AFIT/GLM/LAL/99S-3

AN EXPLORATORY ANALYSIS OF THE
RESPONSIVENESS CAPABILITY OF THE AIR
EXPEDITIONARY WING (AEW) CONCEPT

THESIS

Robert L. Charlesworth, Captain, USAF

AFIT/GLM/LAL/99S-3

Approved for public release; distribution unlimited

19991026 031

The views expressed in this thesis are those of the author
and do not reflect the official policy or position of the
Department of Defense or the US Government

AFIT/GLM/LAL/99S-3

AN EXPLORATORY ANALYSIS OF THE

RESPONSIVENESS CAPABILITY OF THE AIR

EXPEDITIONARY WING (AEW) CONCEPT

THESIS

Presented to the Faculty of the Graduate School of Logistics

and Acquisition Management of the Air Force Institute of Technology

Air University

Air Education and Training Command

In Partial Fulfillment of the Requirements for the

Degree of Master of Science in Logistics Management

Robert L. Charlesworth, B.S.

Captain, USAF

September 1999

Acknowledgments

This thesis could not have been completed without the support and encouragement of many people. I thank my reader, Major Bill Scott, for getting me started in the right direction, and for his dedication from afar. I also want to express my gratitude to Major Alan Johnson, who went above and beyond the original call of reader in this effort for his great patience and for his vigilance in making this a better product.

This thesis effort would not have been possible without all of the assistance I received from men and women in the field. I would especially like to thank Major Chris Miceli from HQ AMC, who provided the meat of the data during my TDY to Scott AFB. I would also like to specifically thank Colonel Gail Duke, who's tremendous expertise in this research arena proved invaluable to this thesis.

An acknowledgements section would not be complete without mentioning the night shift. Guys, thanks for all the foosball. It may take six months for the nicotine and caffeine to be diluted from my bloodstream.

I especially wish to thank my wife Amy. Without her love, understanding, and willingness to mow the lawn I would not have completed this work.

Robert L. Charlesworth

Table of Contents

List of Figures

List of Tables

AFIT/GLM/LAL/99S-3

Abstract

Seven AEF deployments have been accomplished in the Southwest Asia area of responsibility; none have met the Air Force's stringent 72-hour criterion. This exploratory study quantifies the responsiveness capability of the AEW concept. Based on a Monte Carlo simulation methodology this study concludes that the on-call AEW at Mountain Home AFB does not have the capability to meet the 72-hour criterion.

Additionally, this study examined the effect of three departures from the baseline model on responsiveness capability. These departures included: increasing airlift throughput capacity, incorporating limited airlift failure, and employing an air-refueling scenario. The simulation models incorporating these departures resulted in the respective approximate probabilities of 90%, 0%, and 28% for meeting the 72-hour criterion. The limitations of this study are discussed in the context of both the results and their implications, and future research is suggested toward quantifying policy/resource alternatives to assist senior Air Force decision-makers.

AN EXPLORATORY ANALYSIS OF THE

RESPONSIVENESS CAPABILITY OF THE

AIR EXPEDITIONARY WING (AEW) CONCEPT

I. Introduction

Background

In the post-Cold War era (1989 – present), the Air Force experienced severe

downsizing effects due to changes in National Military Strategy (NMS). Prior to 1989,

the Air Force's role in the strategy of deterrence was significant and clearly defined. The

Air Force's long-range bomber fleet and their inter-continental ballistic missiles

combined to create two of the three facets of the nuclear triad (24:54). The evolution of

NMS; however, from nuclear deterrence to power projection/forward presence following

the collapse of the Soviet Union, prompted the military services to redefine their

supporting roles (5:4; 49:66).

In conjunction with the change in NMS, consensus was reached by congressional

leadership that Department of Defense (DOD) force levels attained by the build-up

during the Cold War were no longer necessary in this New World Order. The manning

levels for the DOD were reduced 30% from their Cold War numbers. The Air Force

experienced the greatest percentage of cuts due to its large stake in the deterrence role.

Air Force active-manpower decreased 37% and permanent overseas bases were decreased

from 50 to 17 during this era. In addition to downsizing issues, the Air Force's inability

1

to define its role in the new NMS contributed to considerable force modernization problems (23:18-19; 24:54).

The Air Force's difficulties in defining its own role and marketing this role to Congress in the post-Cold War era were summed up by Colonel Wages:

> Although USAF had been the first service to begin reorganizing for post-Cold War downsizing, had identified its ability to underwrite future national security needs in the 1990 white paper *Global Reach-Global Power*, and had orchestrated an aerial campaign in Operation DESERT STORM that proved airpower's ability to win wars, the Air Force found itself struggling for a constituency after 1991. (49:66)

The Air Force's sister services were much more adept at marketing their niches in the New World Order. The Navy focused on its carrier-dominated forward presence capabilities, while the Army promoted its identity within the new NMS as a peacekeeping/peacebuilding force. The Marines also marketed themselves by promoting to Congress their effectiveness in noncombatant evacuation operations. The Air Force, alone, failed to develop and market its role in the new NMS. Consequently, force modernization efforts met severe political opposition (49:66-67).

Political opposition manifested itself through congressionally mandated requirement reductions. Air Force plans to purchase 120 new C-17 airlift transports were thwarted by a resistant Congress and new purchases were capped at 40. The continuation of the acquisition program for the F-22 fighter was politically threatened, and the long-range bomber force saw its numbers decrease by two-thirds down to 184 active aircraft (49:66). The outlook for the Air Force was grim. Colonel Haffa illustrated this dim perspective when he remarked, "It is not the world in which the Air Force grew up and

prospered. It could be a world in which the Air Force, as we know it will not survive"
(24:58).

As late as 1994, USAF leadership was searching to define the Air Force's role in contributing to NMS. In October 1994, President Clinton executed Operation VIGILANT WARRIOR in response to the massing of Iraqi armor and troops near Kuwait's northern border. U.S. Central Air Force's (USCENTAF) Commander, Lieutenant General John Jumper, deployed to Riyadh as the Joint Force Air Component Commander (JFACC). The operation involved the deployment of several thousand personnel and over forty aircraft from Continental U.S. (CONUS) bases (46). During the deployment General Jumper observed that "the Iraqis ceased rattling their sabers when the first air augmentees arrived in theatre" (49:68).

The quick retreat of Iraqi troops from the border dispelled the crisis; however, the deployment costs incurred by the US government were high. General Jumper's observations as JFACC led him to two conclusions:

> (1) a relatively small, well-rounded combat force capable of immediate reaction from the US was necessary to deal with unexpected fast-breaking contingencies, and (2) such a force actually could have the same deterrent value as a much larger, less agile force. (49:68)

In addition, Jumper reasoned that the deployment of such a force could achieve the same deterrent objectives at a lower overall cost than larger deployments of forces. General Jumper's conclusions from Operation VIGILANT WARRIOR, coupled with the Air Force's need to develop power projection and forward presence options, led his staff at USCENTAF to create the Air Expeditionary Force (AEF) concept (49:68). Until October

1995, the AEF concept consisted of a collection of staff summary predictions within the USCENTAF staff (46).

In October 1995, U.S. Central Command's (USCENTCOM) Commander in Chief (CINC) gave General Jumper a chance to validate his concept. Due to the cutbacks within the Navy, continuous coverage during aircraft carrier rotations was not possible. USCENTCOM's CINC requested an AEF to compensate for the gap in carrier coverage (5:3; 38:6). The subsequent deployment of eighteen F-16 aircraft to Bahrain in the Southwest Asia (SWA) Area of Responsibility (AOR) was the first AEF (31:7). To date, seven AEFs have been completed, and the AEF concept has made significant progress since AEF I in 1995 (11:2-20).

Problem Statement

The USAF Chief of Staff, General Michael Ryan, recently announced his intentions for converting the Air Force to an Expeditionary Aerospace Force (EAF). His plan calls for ten AEFs and two on-call Air Expeditionary Wings (AEWs) to be created by 1 January 2000 (42). Each of the AEFs will be available at specific times of the year "to meet the nation's steady state contingency requirements" (15:2). The AEWs, on the other hand, will be on-call and provide a dedicated crisis response capability and "are designed to meet CINC-identified time-critical mission objectives" (15:2). While the Air Force has quantified AEF/AEW capabilities, some of these capabilities have yet to be validated. Although mission capabilities have been validated by past AEFs, the AEW 72-hour response capability has yet to be achieved. The failure of past AEFs to meet this response capability raises the question: Can it be achieved?

The terms AEF or AEW are used throughout this thesis to represent more than one meaning. At times these terms represent a force capability; however, in the event that an AEF/AEW has been deployed the term may represent the resulting deployment. Each AEF/AEW is comprised of several Unit Type Codes (UTCs). These UTCs represent specific force packages. The mission capability of each AEF/AEW exists as a sum of the UTC capabilities. Therefore, in order to quantify the capability of an AEF/AEW, planners must first identify the UTCs assigned to each AEF/AEW. Next, it is necessary to determine the capability of each of these UTCs. The mission capabilities for each UTC are well documented in Mission Capability Statements (MISCAPS). The validation process for UTC inclusion in the MISCAPS is intense and iterative in nature (13:17-18). Therefore, the mission capability of an AEF/AEW may be ascertained by listing the UTCs. Conversely, the time-based capability of the AEW has not undergone the same validation process as the mission capability for UTCs. The effort to define both the AEW and AEF in terms of UTCs is an ongoing process.

In September 1998, an announcement by General Ryan implied there would be a difference between the AEW and the AEF (41). Actually, the AEW differs from the AEF with regard to the 72-hour response requirement. Additionally, the AEW will eventually exist as a force module with a standard list of UTCs. This ensures that supported CINCs know the make-up of the forces they will receive when they request an AEW. Whereas each of the ten AEFs will be tailorable to the CINC's specific mission requirements, an AEW will be much more rigid in its make-up. This rigidity reduces uncertainty for AEW planners and enables the AEW to respond more rapidly to the CINC's requirements (20).

Currently, the Draft Concept of Operations (CONOPS) for EAF implementation states that an AEW is able to *demonstrate operational affect* (i.e., put bombs on target) 48 hours after a Chairman, Joint Chiefs of Staff (CJCS) Execute Order, given an assumption of 24 hours of Strategic Warning. However, a comprehensive review of past AEFs reveals that this 72-hour response capability has never been met. Determining whether or not future AEWs will have this capability is the underlying management question this research seeks to answer (15:2). Interestingly, the justification for using 72 hours versus another time was not found by this research.

Research Objectives

The purpose of the research effort is to determine the probability that an AEW can meet the 72-hour criterion. This endeavor may serve as one step in the validation process for the response capability of an AEW. The research will address four objectives to address the stated problem. Each objective of must be met before proceeding to the next.

Objective 1. The objective of phase 1 is to develop a timeline of the key events necessary from Strategic Warning through an actual demonstration of operational affect for a specific AEW scenario. The major undertaking involved with deploying and employing an AEF/AEW can be divided into a number of concrete steps or key events. These include actions the deploying unit must accomplish as well as steps taken by Air Mobility Command (AMC) in deploying each unit. Steps may include generation of deploying aircraft, recall of AMC crews, crew rest, personnel preparation, cargo and passenger loading and unloading, flight times, and regeneration.

This research effort will first seek to determine which key events should be included in determining the time capability of an AEF. The assumptions for the scenario under investigation will dictate some of the timeline, however much of the timeline will be applicable to a generic deployment process.

Objective 2. The objective of phase 2 is to approximate distributions for each of the key events on the timeline. As mentioned, the current goal, or stated capability of an AEF, is to deploy and employ at the deployed location in 72 hours. This includes 24 hours of Strategic Warning followed by 48 hours of execution. Frequently, response capability for deployment packages is determined by simply summing the expected duration/time required for the completion of each key event. In reality the time necessary to complete key events exists as an expected value with a variance.

Each of the key events leading up to the employment of an AEF/AEW at a deployed location should be characterized by its expected duration as well as its variance. In order to provide the National Command Authority (NCA)/CINCs with the best possible information, these variances must be accounted for when quantifying the response capability of an AEW.

Objective 3. The objective of phase 3 is to assess the capability of an AEW to meet the 72-hour requirement given a set of AEW assumptions and the distributions for the key event times approximated in phase 2. The methodology for assessing this capability will be simulation.

Objective 4. The objective of phase 4 is to assess the effects of changing assumptions developed during research objective 1 on the capability of the AEW to meet the 72-hour requirement. In order to accomplish this analysis, three assumptions will be

altered. This phase of the study entails altering the maximum-on-ground constraint assumption, the *tanker bridge* assumption, and the no-failure assumption.

First, it will be determined whether a change in the working maximum-on-ground (MOG) airlift capacity constraint will improve the probability that an AEW can meet the 72-hour requirement. The AEW working group at Mountain Home AFB has stated that an increase in airlift capacity throughput is needed in order to ensure the 72-hour criterion is met. The throughput capacity is dependent upon the working maximum-on-ground (MOG) constraint at both the deploying base and the deployed location. The working MOG is simply the number of AMC airlifters that may be loaded concurrently at an airfield (13:24; 14:5; 20). The AEW working group is currently developing a concept of operations based on the assumption that air refueling will be accomplished on all deploying airlifters (20). Although this assumption is not made in addressing research objective 3, this research phase attempts to assess the impact of air refueling on the AEW response capability. Finally, research objective 3 entails developing a simulation model based on an assumption of perfectly reliable deploying airlifters. This research objective assesses the impact of limited failure and mean time-to-repair on the responsiveness capability of the AEW. These three departures from the base model developed to address research objective 3 are discussed more extensively in Chapter III.

Scope

The deployment process timeline created in phase 1 of the research effort will be specific to the assumptions of an AEW deployed from Mountain Home AFB. One of these assumptions is that the package is an Eagle Force package. The Eagle Force

8

Package consists of 12 F-15Cs, 12 F-16CJs, 12 F-15Es, 4 B-1s, and 4 KC-135s (19).

Other assumptions concerning the size of the deployment package to be moved in the

first 72 hours as well as the conditions of the scenario are made in Chapter III. These

assumptions will not apply to every deployment. However, many of the key events on

the timeline as well as their distributions should be applicable to a process of quantifying

the reaction time of other AEWs or AEFs. More importantly, this thesis will document a

process for evaluating a response-time capability to be used by deliberate and crisis

action planners.

This research will serve as an example for conducting this evaluation and should

not be used to generalize the responsiveness capabilities of other AEFs/AEWs; however,

Air Force leadership may use the process developed in this research as a framework for

evaluating time-critical reaction capability for future AEW/AEF deployments.

Research Questions

To meet the objectives of this study, the following research questions were

developed:

1. What key events represent the critical path for the first 72 hours of an AEW deployment timeline?

2. What are the approximated distributions for each of the key events in this deployment timeline?

3. What is the current probability for completing an AEW in 72 hours?

4. What are the new probabilities for completing an AEW given changes in conceptual model assumptions to include: throughput capacity (i.e., increase in working maximum-on-ground), maintenance downtime due to airlift failures, and accomplishment of air-to-air refueling for all deploying airlifters?

Methodology

The tool used in this research effort is simulation modeling. Simulation modeling is used due to the complexity inherent to the deployment process. Simulation modeling allows for accurate modeling of real systems to complex for analytical models, control of experimental conditions, repeatability, and comparison of alternative system designs (6:3-7).

The ability of the AEW to meet the 72-hour criterion will be quantified as a probability using the results of simulation modeling. This ability will be analyzed using traditional statistical techniques. These techniques will be used for the results of the simulation model developed to address research questions 3 as well as the results of the three departures from this model accomplished to address research question 4.

Overview of Remaining Chapters

This research effort begins with an examination of current literature pertinent to the topic. The literature provides a framework for consultation with experts to help document the deployment process timeline. The actual literature review and consultation with experts is used to complete research objectives 1 and 2.

As mentioned, simulation is used in this research effort as a methodology to generate probability distributions representing the amount of time required for an AEW to demonstrate operational effect. Statistical analysis is accomplished on the baseline model to address research question 3. Finally, the baseline simulation model is altered to evaluate the effects of increased throughput capacity, potential maintenance downtime, and the air refueling on the probability of adhering to the 72-hour AEW criterion.

Summary

This chapter described the origination of the AEF/AEW concept as a tool for forward presence/power projection. In order for the AEF/AEW to assume this role as a military instrument it must be responsive. Chapter I also discussed the need for quantifying the responsiveness capability of a rapid-response AEW. Additionally, the research objectives as well as the research questions necessary to meet those objectives were formulated.

The remaining chapters will explain the steps taken to address the four research objectives. In Chapter II, an overview of the planning process, the AEW concept, and a history of past AEFs are presented. Chapter III provides an explanation of the research methodology and the assumptions made to meet the objectives of this research. In Chapter IV, the analysis portion of this research and the results of this analysis are presented. Finally, Chapter V discusses the conclusions of the research effort, Air Force implications, and recommendations for future research.

II. Background

Chapter Overview

This chapter focuses on research objective one of this study. This entails a review of the literature aimed at describing the AEW concept as well as its place in the joint planning environment. Also, a personal interview process is used to supplement the literature review. The major topics of this chapter concentrate on the planning process, deployment process, past AEFs, and the current EAF concept as it pertains to deployments in the Southwest Asia area of responsibility.

The EAF concept was developed as a response to changing National Military Strategy (NMS). An AEF/AEW is best viewed as a capability for meeting the requirements outlined in the NMS. In order to fully understand the role of the AEF/AEW as a force capability alternative, a synopsis of the planning process is necessary.

The AEW concept, once fully developed, will be a force option consideration for decision-makers and members of the Joint Planning and Execution Community (JPEC) during both deliberate as well as crisis action planning. However, the exact capability of the AEW/AEF must be quantified so both the JPEC and National Command Authority (NCA) can compare between force option alternatives. The responsiveness capability of an AEW/AEF can only be quantified through an analysis of the deployment process. In order to facilitate this analysis, this chapter defines the deployment process so that a detailed timeline flowchart can be accomplished. Finally, a thorough description of the currently evolving AEW/AEF concept for deployment to the Southwest Asia area of responsibility is provided along with its relationship to the deployment process.

National Security Strategy

The National Security Strategy (NSS) is a biennial product created by the National Security Council System (NSCS). The National Security Council, comprised of the President, Vice-President, Secretary of Defense (SECDEF), and Secretary of State, develop the National Security Strategy to explain the national security interests and objectives of the U.S. Furthermore, this document illustrates the intended use of political, economic, military, and informational power to achieve national objectives while protecting national security interests. The NSS provides broad direction and establishes the framework for the Joint Strategic Planning System (JSPS), the Biennial Planning, Programming, and Budgeting System (BPPBS), and the Joint Operation Planning and Execution System (JOPES). The current National Security Strategy is titled *A National Security Strategy for a New Century* (4:502).

The current National Security Strategy does not specifically mention the AEW; however, it does make reference to the sixth AEF (also known as the 347 AEW). The NSS alludes to the AEF/AEW concept by stating, "our forces in the Gulf are backed by our ability to rapidly reinforce the region in time of crisis, which we demonstrated convincingly in late 1997 and early 1998" (51:52). This illustrates the significance of the AEF concept to the national objectives outlined in the NSS.

National Military Strategy

National Military Strategy (NMS) is derived from the National Security Strategy and is a product of the Joint Strategic Planning System. The Chairman, Joint Chiefs of Staff (CJCS) on a biennial basis submits the NMS to the National Security Council

documenting his recommendations for force structure as well as the intended use of military assets to ensure that the national objectives described in the NSS are achieved 4:501; 7:4).

The current NMS, *Shape, Respond, Prepare Now -- A Military Strategy for a New Era*, details two national military objectives: (1) Promote Peace and Stability and when necessary (2) Defeat Adversaries. "Although the military by itself can rarely address the root causes of conflict—as it often stems from political, economic, social, and legal conditions that are beyond the core competence of the military to resolve," (29) one method for promoting peace and stability, according to the current NMS, is through the use of peacetime deterrence. National Military Strategy states, "deterrence means preventing potential adversaries from taking aggressive actions that threaten our interests, allies, partners, or friends" (29). The NMS declares that one element used to accomplish deterrence is through, "our capability to rapidly project and concentrate military power worldwide" (29). This "ability to rapidly and effectively deploy and sustain US forces" (29) is a strategic concept defined within the NMS and termed power projection. One means for achieving power projection is through the use of a flexible deterrent option (FDO). The flexible deterrent option concept will be discussed later in the Crisis Action Planning section of this chapter.

The Chairman, Joint Chiefs of staff depends upon products generated by the Joint Strategic Planning System, Biennial Planning, Programming, and Budgeting System, and Joint Operation Planning and Execution System in order to develop his National Military Strategy. These systems are interrelated, and products of each system are integral to the functions within the other systems. The products of the Joint Strategic Planning System

include: the Joint Strategy Review (JSR), the Joint Strategic Capabilities Plan (JSCP), the Joint Planning Document (JPD), the Chairman's Program Assessment (CPA), and the NMS as already described (4:502).

Joint Strategic Planning System

The products of the JSPS are briefly described in the following paragraphs.

Joint Strategy Review. The JSR represents a continuous process of monitoring the international environment for issues, threats, or factors that may have impact on the NMS. The JSR consists of three products used to update NMS: JSR issue papers, JSR long-range vision paper, and the JSR annual report (4:502; 7:3-4).

Joint Strategic Capabilities Plan. The JSCP provides guidance to the unified commands as well as the military services. It is the single source document to direct the unified CINCs to perform strategic planning. Therefore, the JSCP serves as the catalyst to begin deliberate planning which will be explained later in this chapter. Additionally, the JSCP apportions forces to the CINCs and assigns tasks and missions congruent with NMS (4:502).

Joint Planning Document. The JPD is a stand-alone document used as an input to the BPPBS. The JPD is sent to the SecDef for consideration during his preparation of the Defense Planning Guidance (DPG). The JPD contains the CJCS's priorities for programs and requirements considered during the evolution of the BPPBS to include acquisition (4:502; 7:6).

Chairman's Program Assessment. The CPA is the CJCS assessment of the Program Objective Memorandum (POM) towards the end of the PPBS process. The

CPA includes the Chairman's recommendation for adjustments to any of the Service POMs. The CPA is given to the SecDef for consideration before the Program Decision Memorandum (PDM) (4:502; 7:5).

Biennial Planning, Programming, and Budgeting System

The BPPBS is the DoD process to establish, maintain, and revise the Future Years Defense Plan (FYDP), as well as the DoD portion of the President's Budget. The Secretary of Defense is responsible for oversight of this system. The BPPBS, combined with the Joint Strategic Planning System, seeks to provide the unified CINCs with the optimum mixture of missions, forces, equipment, and support in keeping with NMS (4:502; 7:7-9).

Joint Operation Planning and Execution System

Essentially, JOPES exists as the combination of a single set of automated data processing procedures and the networked computer hardware and software necessary for the planning and execution of all military operations. JOPES ensures that all users throughout the DoD use the same vocabulary and procedures in training, planning, and actual execution of military operations. JOPES is used as the command and control system to effectively and efficiently manage resources during both deliberate and crisis action planning. JOPES allows the Joint Planning and Execution Community to plan and direct the use of resources. In this case, resources are accounted for in the JOPES database as a shopping list of forces to include personnel and equipment (27; 28:26).

Personnel and equipment are grouped into force packages, which provide specific wartime capabilities. These force packages are designated by a five-character alphanumeric code known as a Unit Type Code (UTC). For instance, the UTC 3FQDF represents the personnel, aircraft, and equipment required to employ and support 18 F-15Cs. This particular UTC consists of over 300 personnel and 300 short tons of cargo. This UTC is directly related to combat and does not contain base operating support (BOS) resources. In order to deploy this UTC to a bare-base environment, additional UTCs that provide combat support and combat service support capabilities would also need to be tasked (25:1-7).

Currently, an AEF/AEW exists in the JOPES database as a collection of many individual UTCs. Air Force planners are presently endeavoring to create a force module for the AEW. A force module is a linking of UTCs within the JOPES database to enhance the usability of the JOPES by allowing deliberate or crisis action planners to easily fill capability requirements with appropriate force modules. A force module is then a group of UTCs within the JOPES database, which in the aggregate represent a specific capability (21; 25).

Collectively, the preceding discussion of National Security Strategy, National Military Strategy, Joint Strategic Planning System, Biennial Planning, Programming and Budgeting System, and Joint Operation Planning and Execution System provide the necessary background for a description of the deliberate and crisis action planning processes.

Deliberate Planning

As stated, the Joint Strategic Capabilities Plan initiates deliberate planning. Each of the services, after receiving the JSCP, translates this joint document into service unique planning guidance and requirements. The Air Force version of this translation is known as the War and Mobilization Plan (WMP). Deliberate planning is accomplished through JOPES, which acts as a framework for all joint planning. Deliberate planning is a peacetime process of translating national objectives into military capabilities, and it exists as a "planning process for the deployment and employment of apportioned forces and resources that occur in response to a hypothetical situation. Deliberate planners rely heavily on assumptions regarding the circumstances that will exist when the plan is executed" (27). The deliberate planning process consists of five phases: (1) Initiation; (2) Concept Development; (3) Plan Development; (4) Plan Review; and (5) Supporting Plans (4:602). The objective of deliberate planning is to develop operational plans (OPLANs), concept plans (CONPLANs), supporting plans, and functional plans. A brief overview of the events within each phase is included in Figure 1.

The OPLANS that result from deliberate planning are represented within the JOPES database as Time-Phased Force and Deployment Data (TPFDD). The TPFDD contains information regarding the units to be deployed, the routing of forces, movement requirements, and the time-phasing of these movements required to support the OPLAN (18:48).

Currently, AEWs are not part of the deliberate planning process. The AEW concept only exists in the disaggregate. In other words, a supported CINC would need to request each of the UTCs that comprise an AEW in order to receive all of the forces and
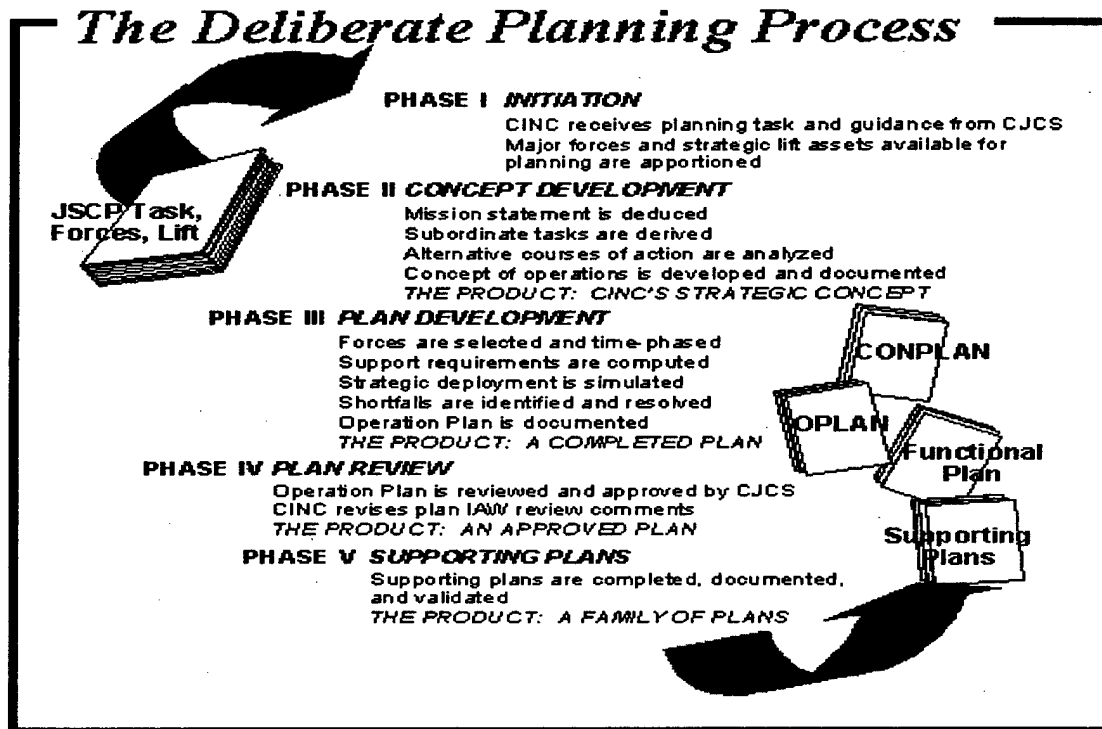
Figure 1. Deliberate Planning Process (4:6-10)

equipment necessary to employing/deploying an AEW. In order to expedite this process, Colonel Gail Duke, Commander, 366th Logistics Group, is one of the lead Air Force planners currently working to create a rapid-response AEW force module (20).

Notwithstanding the amount of effort that is expended in deliberate planning, no plan is perfect. Furthermore, a crisis involving a threat or potential threat to U.S. national interests could occur at any time for which there is no existing plan. In either case, the JPEC engages in a process known as crisis action planning.

Crisis Action Planning

Crisis action planning (CAP) is the accomplishment of time-sensitive joint planning to meet national objectives. CAP is also achieved through the utilization of the Joint Operation Planning and Execution System.

> While deliberate planning is conducted in anticipation of future events, there are always situations arising in the present that might require U.S. military response. Such situations may approximate those previously planned for in deliberate planning, though it is unlikely they would be identical, and sometimes they will be completely unanticipated. Usually, the time available to plan responses to such real-time events is short (4:700).

The CAP process consists of six phases. Each phase and its associated action is shown in Table 1.

Table 1. Crisis Action Planning Phases (4:701)

Phase I	Phase II	Phase III	Phase IV	Phase V	Phase VI
Situation Development	Crisis Assessment	COA Development	COA Selection	Execution Planning	Execution
Event occurs with possible national security implications	CINC'S REPORT / ASSESSMENT received	CJCS sends WARNING ORDER	CJCS presents refined and prioritized COAs to NCA	CINC receives ALERT ORDER or PLANNING ORDER	NCA decides to execute OPORD

Phase I (Situation Development). Many U.S. organizations throughout the world continuously engage in situation monitoring. When an event occurs that is assessed by the monitoring agency as out of the ordinary, or if said event could possibly have an adverse affect on U.S. national interests, then organizations are required to report the event. The focal point for these reports is the National Military Command Center

(NMCC). The CINC is also required to give an assessment with justification that the situation demands higher-echelon awareness. This assessment officially ends Phase I (4:702).

It is important to note in some situations that due to time criticality a rapid response may be required. In such a case, a theatre CINC assessment may also contain a recommended course of action (COA) and the phases of CAP could be compressed or skipped altogether. One of these rapid responses may be the use of power projection. As mentioned in Chapter I, a flexible deterrent option (FDO) is a method for accomplishing power projection and thereby achieving deterrence. By definition a flexible deterrent option is:

> A planning construct intended to facilitate early decision by laying out a wide range of interrelated response paths that begin with deterrent-oriented options carefully tailored to send the right signal. The Flexible Deterrent Option is the means by which the various deterrent options available to a commander (such as economic, diplomatic, political, and military measures) are implemented into the planning process. (27)

The act of ordering a carrier battle group to begin travel to an indicated AOR is one example of a FDO (5). In the very near future, AEWs and "AEFs will be called upon as a FDO, often heading off the need for further engagement by virtue of their early on-scene arrival" (40).

Phase II (Crisis Assessment). The focus of this particular phase is on the Chairman, Joint Chiefs of Staff in coordination with the National Command Authority. The CJCS may choose to remain in this phase, return to Phase I, or progress to the next phase of crisis action planning. During this phase the CJCS may decide to increase military readiness. This may be accomplished through use of a Deployment Preparation

21

Order or a Deployment Order. Specific instructions to various supporting CINCs would accompany these orders. This phase is concluded when the NCA makes the decision to have military options developed for consideration (4:702).

Phase III (COA Development). Based on the NCA's decision to enter Phase III, the CJCS will publish a Warning Order (see Appendix B). The Warning Order directs the pertinent CINC to begin developing COAs. The supported CINC, in turn, sends potential supporting commanders an Evaluation Response Message requesting the identification of forces and resources that may be made available for planning purposes. The supported CINC and his staff first review existing Operation Plans for applicability to the crisis at hand. Next, the Joint Operation Planning and Execution System is used to actually develop possible COAs (4:702).

This planning process is not accomplished in a vacuum. The CINC's staff communicates with the various supporting commands to ensure course of action feasibility. U.S. Transportation Command (USTRANSCOM) is integral to this process. Planners at USTRANSCOM prepare deployment estimates for the supported CINC, help to refine timing, and validate the transportation feasibility of each COA. This phase concludes with the submission of the CINC's Commander's Estimate to the Chairman, Joint Chiefs of Staff. The Commander's Estimate will include the COAs developed during this phase as well as the CINC's recommendation for a particular COA (4:702).

Phase IV (COA Selection). At this point the focus returns to the Chairman, Joint Chiefs of Staff and the National Command Authority. The CJCS fulfills his role in this phase by giving his own recommendation to the NCA, and providing advice as needed. The CJCS may decide to issue a Planning Order before actual selection of a COA. The

Planning Order is designed to expedite execution planning. Upon selection of a specific course of action by the National Command Authority, the Chairman, Joint Chiefs of Staff issues an Alert Order. The Alert Order concludes Phase IV and begins execution planning (4:702).

Phase V (Execution Planning). The CINC translates the selected COA into an Operation Order (OPORD) during this phase. Also during this phase, detailed movement requirements are identified and scheduled, shortfalls and limitations are resolved, sustainment requirements are developed, and initial deploying forces are identified. The JOPES system is used extensively throughout this phase. This phase is concluded with a National Command Authority decision to execute the OPORD developed by the supported CINC (4:702).

Phase VI (Execution). After the NCA decision, the CJCS publishes an Execute Order by direction and authority of Secretary of Defense. USTRANSCOM is responsible for using its resources to comply with the movement requirements detailed in the Operation Order. The supporting CINCs furnish forces and resources to the supported CINC in accordance with the OPORD. Finally, the supported CINC monitors the execution of the OPORD through JOPES, and the CINC continues execution of the OPORD until the crisis is resolved or the operation is cancelled (4:702).

The preceding paragraphs described the deliberate and crisis action planning process. The description of these processes provides a framework for discussing the AEW deployment concept.

AEW Deployment Concept

As mentioned in Chapter I, General Michael E. Ryan recently announced plans to redesign the Air Force into an Expeditionary Aerospace Force (EAF). General Ryan's plan calls for ten AEFs and two on-call AEWs to be created by 1 January 2000 (22). This recent announcement lends credibility to the AEF concept; however, many challenges lay ahead for the Air Force in refining the AEF concept. First, the Air Force will need to provide the National Command Authority with accurate information regarding capabilities and costs of AEF/AEW deployments. In order to provide this information, the Air Force must first define the terms AEF and AEW. Furthermore, accomplishing General Ryan's vision of an Expeditionary Aerospace Force in the 21st Century will require continuous improvements in the efficient use of limited resources such as airlift, manpower, and equipment.

Prior to General Ryan's announcement, the terms AEW and AEF were used interchangeably; however, many steps are ongoing to define the AEW and the AEF. Although the development of AEF/AEW concept of operations is an ongoing effort, many of the aspects are widely accepted by the Air Force planning community. It is important to note at this point that assertions made in this study represent a snapshot in time, and current AEF/AEW concepts are certainly subject to change as the EAF evolves and refines the AEF and AEW.

The current intention of Air Force planners is to standardize the AEW package in order to reduce uncertainty for AEW personnel. In contrast, AEF packages may be tailored according to CINC requirements "such as command and control, jamming, electronic intelligence, signals intelligence interception, combat search and rescue, and

24

air refueling" (31:6). A standardized AEW package will enable planners to accomplish detailed planning, thus increasing their capability to rapidly respond.

Another difference between the developing AEW and AEF concepts is based on the idea of the lead unit. During past AEF deployments a lead unit has been designated from the three CONUS based units deploying to form the AEF (31:8). The lead unit is responsible for bringing all base operating support forces required at the deployed location. These housekeeping capabilities would typically consist of the people and equipment necessary to perform operations such as security, civil engineering, fire protection, communication, food services, medical, and intelligence. Additionally, the lead unit is responsible for maintaining corporate knowledge gained by deploying to each specific location (31:8-9). In contrast to this concept, the on-call AEW at Mountain Home AFB provides all of the base operating support (except force protection) as well as the fighters, bombers, and tankers (20). Therefore it is conceivable and even likely that the forces and weapons systems comprising future AEWs and AEFs may be very similar. The only difference is the method in which they are sourced. AEFs are a mixture of forces from different bases, while the Mountain Home AEW deploys almost entirely from Mountain Home AFB. Recall from Chapter I that the on-call AEW at Mountain Home AFB is the subject of this study.

Although the AEF/AEW Concept of Operations is currently under development, there are several concepts likely to be incorporated based on the evolution of the AEF concept in the last five years. One accepted concept entails deploying AEF/AEWs to previously visited foreign airfields. Furthermore, each of these airfields is equipped with a variety of prepositioned assets such as: vehicles, tents, meals ready-to-eat (MREs), and

supplies. These prepositioned assets, also known as War Reserve Materiel (WRM) are stored in large metal buildings, called K-SPANs (30:4-9). A concept not yet validated by past AEFs would have a force deploying as an additive force during times of crisis by emptying K-SPANS to use necessary WRM, using the K-SPANS as temporary lodging, and eating MREs until such time as hostilities subside and a tent city can be erected (30:4-9). The lessons learned from the completion of seven AEF deployments to three countries within the Middle East are currently being used to establish AEF/AEW CONOPS and planning assumptions. A detailed overview of these past AEFs is included later in this chapter.

The political benefits of AEF deployments to these countries during peacetime have already been realized to some extent. Deployed AEF forces work closely with military members of the host country. This has resulted in a fostering of goodwill and enhanced communications between the U.S. and the political leadership in Jordan, Bahrain, and Qatar, all AEF locations. This benefit has opened the door to overcoming the constraint of diplomatic clearances (discussed in Chapter III). Additionally, the USAF has begun to realize the benefit of drawing down some of the forces permanently deployed to the Southwest Asia area of responsibility, as the AEF concept becomes more credible. This is one method to decrease the high operations tempo problem present in today's Air Force (30:4-9).

As discussed previously, the mission of the AEW is aligned with the Air Force's mission to develop options for power projection and forward presence FDOs. The AEF/AEW mission is twofold, consisting of both political and military components. Politically, the AEW/AEF offers the NCA an additional option in accomplishing power

projection and forward presence. Militarily, the AEW serves the mission requirements of the various regional CINCs. An AEW may be deployed to act as a rapid, responsive, and reliable additive force in the event of imminent hostilities or as a filler force in scenarios such as a carrier gap (30:6). Although AEFs have been accomplished in Pacific and European AORs, this study focuses on a single area of responsibility for the sake of simplicity.

The package size and make-up of an AEF/AEW are related to the responsiveness and lethality/capability, respectively, of the force. Although a CINC's requirement for response time and lethality are likely to vary according to situation, a standard package is used for the AEW. Although the AEW is a work in progress, one current standard, known as the Eagle Force Module, consists of 12 air superiority fighters (F-15Cs), 12 strike aircraft (F-15Es), 12 Suppresion of Enemy Air Defense (SEAD) aircraft (F-16CJs), 4 long-range bombers (B-1s), 4 air-to-air refeulers (KC-135s or KC-10s), and Army air defense artillery capability (Patriot missiles). This research effort will use this package for analysis in later chapters (2; 19).

Although many Air Force planners are now contributing to the development of AEF/AEW CONOPS, the seven AEFs completed in the last five years may be the best sources of information in assessing the response capability of future AEF/AEW deployments. For this reason it is necessary to discuss each of the seven AEFs. An overview of these AEFs is included in Tables 2 and 3. A complete discussion of each AEF follows.

Table 2. AEF Deployments to USCENTCOM (11:2-20)

Number	Dates	Location	Designation
1	30 Oct 95 - 18 Dec 95	Shaikh Isa, Bahrain	AEF I
2	12 Apr 96 - 26 Jun 96	Azraq, Jordan	AEF II
3	2 Jul 96 - 21 Aug 96	Doha, Qatar	AEF III
4	19 Feb 97 - 21 Jun 97	Doha, Qatar	4 AEW
5	19 Sep - 21 Oct 97	Shaikh Isa, Bahrain	366 AEW
6	22 Nov 97 - Apr 98	Shaikh Isa, Bahrain	347 AEW
7	Mar 98 – Jun 98	Shaikh Isa, Bahrain	366 AEW

Table 3. AEF Packages (11:2-20; 37)

AEF I (1)

12 F-16CG	347 WG	Moody AFB
6 F-16C2	20 FW	Shaw AFB

4 AEW (4)

12 F-15E	4 FW	Seymour Johnson AFB
12 F-16C	27 FW	Cannon AFB
12 F-16C	169 FG	McEntire ANGB
12 F-16CJ	20 FW	Shaw AFB

AEF II (2)

12 F-15C	1 FW	Langley AFB
12 F-16CG	347 WG	Moody AFB
6 F-16 CJ	366 WG	Mountain Home AFB
4 KC-135R	97 ARW	Fairchild AFB

366 AEW (5)

6 F-15C	366 WG	Mountain Home AFB
6 F-15E	366 WG	Mountain Home AFB
10 F-16CJ	366 WG	Mountain Home AFB
2 KC-135R	366 WG	Mountain Home AFB
2 B-1	366 WG	Mountain Home AFB
Patriot Batt.	11 ADA	Fort Bliss

AEF III (3)

12 F-15 E	4 FW	Seymour Johnson AFB
12 F-15C	33 FW	Eglin AFB
6 F-16CJ	20 FW	Shaw AFB
4 KC-135R	319 ARW	Grand Forks AFB
2 B-52G	2 BW	Barksdale AFB

347 AEW (6)

12 F-15C	33 FW	Eglin AFB
12 F-16C	347 WG	Moody AFB
6 F-16CJ	20 FW	Shaw AFB
2 B-1	28 BW	Ellsworth AFB
4 KC-135R	97 ARW	Fairchild AFB
Patriot Batt.	3 ADA	Fort Bliss

366 AEW (7)

12 F-15C	366 WG	Mountain Home AFB
12 F-15E	366 WG	Mountain Home AFB
12 F-16CJ	366 WG	Mountain Home AFB
2 B-1	366 WG	Mountain Home AFB
4 KC-135R	366 WG	Mountain Home AFB
Patriot Batt.	11 ADA	Fort Bliss

Overview of Past AEF Deployments

Although each of the AEFs differ in a number of different areas, generally accepted standards have emerged with regard to the AEF concept. The lessons learned from past AEFs have allowed planners to develop assumptions, identify constraints, and improve concept of operations for the future use of AEF/AEWs. As previously mentioned, this research is concerned with determining whether the responsiveness capability of the AEW to the Southwest Asia area of responsibility will meet the 72-hour criterion, set by senior Air Force leadership. Therefore, discussion of past AEFs will focus on the characteristics of each AEF affecting the ability of the AEF to plan, deploy, and employ strike package assets within the 72-hour criterion. Although none of the AEFs complied with the 72-hour requirement as it is described in this research effort, a discussion of the characteristics of each AEF will provide justification for the assumptions used in Chapter III.

The characteristics of each AEF are described in the following sections based on several sources. Several of the AEFs are well-documented in previous thesis efforts, journal entries, after action reports, and assorted newspapers. Unfortunately, the characteristics that affected the ability of the AEF to plan, deploy, and employ were not entirely available through these sources. In order to describe the events that occurred, in many instances, personnel were contacted from the pertinent organizations.

The characteristics of each deployment may be categorized as plan, deployment, or employment characteristics. The plan characteristic for each AEF includes: timing associated with issuance of Warning Order/beginning of Strategic Warning, the aircraft package size/mix, the receipt time of Execute Order, and the size of the deployment

package required to be at the deployed location prior to the arrival of the aircraft package. The timing associated with Strategic warning and the Execute Order determine whether or not the stringent 24 hours of Strategic warning followed by an Execute Order are met. The AEF must then have the capability to put bombs on target 48 hours after the Execute Order. The aircraft package has an effect on the size of the deployment package required to be at the deployed location prior to the arrival of the aircraft package. This package may include base operating support as well as the personnel and equipment required to actually regenerate the strike package (2:8; 22).

Deployment characteristics include details about the *tanker bridge*, airlift information, and enroute stops. The *tanker bridge* refers to the capability for AMC to provide tanker support to deploying aircraft as well as airlifters laden with deploying personnel and cargo. The discussion of each AEF contains information regarding the number, type, and timing of the airlifters used to deploy. Finally, the use of enroute stops for airlifters is discussed due to the effect this may have on overall timing (32).

Employment refers to the characteristics of the deploying aircraft. For most of the AEFs, the strike aircraft actually met the 48-hour criterion following the Execute Order even though the 72-hour requirement was not met. The number of aircraft regenerated to actually fly to a target has evolved. Currently, the planning assumption used for the AEW is 4X4X4 or 4 F-15Cs, 4 F-15Es, and 4 F-16CJs (19).

The following sections will provide an overview of each of the seven AEFs to the Southwest Asia area of responsibility. The AEW concept is used as frame of reference for this discussion. The assumptions and requirements for the AEW, as used in this

research effort, will be alluded to by this discussion. Once again, these assumptions will be enumerated in Chapter III.

AEF I. The first actual AEF deployment occurred in October 1995. The deploying units for this AEF were the 347 Fighter Wing, Moody AFB, GA and the 20 Fighter Wing, Shaw AFB, SC. These bases deployed 12 F-16CGs and six F-16CJs respectively to Shaikh Isa, Bahrain. F-16CJs were used to fulfill the SEAD role due to their High-Speed Anti-Radiation Missile (HARM) Targeting System (HTS) capability. AMC moved approximately 318 short-tons of cargo and deployed 431 personnel (33; 47:49-50).

Although valuable lessons were gleaned from this first AEF it did not serve as validation for the no-notice rapid reaction 72-hour criterion for several reasons. First, AEF I wing-level planning began several weeks before actual execution. Wing personnel were aware of the deployment location as well as approximate timing. This information is essential for the completion of many deployment actions, but may not be available for future deployments when the stringent no-notice AEW deployment CONOPS are applied. The AEF I deployment package was considerably smaller than the AEW concept of today. The entire deployment package of AEF I is less than the amount of cargo and personnel required to be in place at the deployed location before the fighters arrive at the deployed location in the current AEF concept of operations (47:49).

Execute Order for AEF I was given 20 October, 1995. Deployment operations continued until 28 October. Although this timeline falls far short of today's response criterion, AEF I proved to Air Force leadership that a rapid response capability was viable (47:59).

AEF II. The AEF II deployment was a significant increase in firepower when compared to the first AEF. AEF II was a 30-ship fighter package consisting of 12 F-15C's from the 1 FW, Langley AFB, VA; 12 F-16CGs from 347 FW, Moody AFB, GA; and six F-16C/Js from the 366 Composite Wing at Mountain Home AFB, ID. In addition, 4 KC-135s were deployed from 97 ARS, Fairchild AFB, WA. The 1 FW was lead unit for this deployment. AEF II was deployed in April 1996 to Azraq Air Base, Jordan. Forces were redeployed to CONUS in June of 1996. AEF II involved the deployment of over 1300 personnel and 1000 short-tons of cargo (3; 47:51-53).

This was not a short-notice tasking for the bases deploying forces for AEF II. The bases involved with this AEF had several weeks to plan and coordinate the deployment; however, AEF II was the first step in establishing the 72-hour criterion. Many associated with this deployment, including Brigadier General Looney, claimed that operational effect was established within 48 hours of the Execute Order (31:8). In fact, this was the claim of several AEFs accomplished thus far. The disconnect has been in counting only the fighter timeline while ignoring the timeline for deployment of support personnel and cargo (47:59-60). In the case of AEF II actual deployment operations were commenced several days before the Execute Order was given. Langley AFB had actually deployed several airlifters full of deploying cargo and personnel before the arbitrary issuance of a pre-planned Execute Order.

The two-fold objective of AEF II was met despite the failure to comply with today's 72-hour criterion. First, AEF II proved that the fighters could indeed meet a 48-hour timeline for operational affect after execution. Secondly, Langley AFB deployed support infrastructure equipment that was placed into storage after the AEF for use in

32

future Southwest Asia deployments. This requirement for the deployment of infrastructure assets contributed to making AEF II the largest AEF in terms of movement requirements to date. AEF II required a total of 88 C-141 equivalents whereas the next largest deployment, AEF III, required 44 C-141 equivalents. Although AEF II did not validate the concept of a no-notice, rapid-response force capable of meeting the 72-hour criterion it was the next logical step on the path towards validation of the AEF concept (3; 47:51-53).

Shortly after the return of AEF II, Langley AFB submitted a 65-page consolidated lessons learned report that is still used by AEF/AEW planners today. One comment was that "with only 6 Suppression of Enemy Air Defenses (SEAD) aircraft and 10 pilots, the current AEF composition is inadequate. Consequently, the overall mission capability was diminished, and in some cases denied" (1). As a result successive AEF planning has evolved to the deployment of 36 fighter aircraft versus 30. Many of the assumptions and planning factors developed for the second AEF are still in affect for AEF/AEW planning today (20).

Another concept advanced during AEF II revolved around the importance of prioritizing the first several chalks of cargo and personnel required to arrive before the combat jets. A chalk represents one deploying airlifter. Planners involved in this AEF were informed that airlift scheduled to arrive before the combat jets must contain all cargo and personnel necessary to conduct operations for the first seven days. This was significant because most Unit Type Codes (UTCs) are built for thirty days of operations without sustainment. This concept resulted in a 7/23-day split of tasked UTCs, whereby cargo and personnel were prioritized on a micro-level so that all of those capabilities

33

deemed necessary for the first seven days were deployed according to order of importance. Langley termed this list of equipment and personnel the Initial Strike Package Airlift (ISPA) (3; 10). Currently, the term Initial Combat Capability (ICC) is used by AEF planners to refer to this list of equipment and personnel.

The prioritization of equipment and cargo was necessary due to the limitations of the TPFDD. Although the purpose of a TPFDD is to communicate the time-phasing of forces into a theatre of operations this is only accomplished on a macro-level. The TPFDD assigns Required Delivery Dates (RDD) for specific UTCs. For example, a TPFDD may task the wing to send a 12-ship aviation package, an accompanying munitions UTC, and several support UTCs. However, all of these UTCs may have the same RDD of C-Day + 5 (see Appendix B), whereas the first airlifter arrives at the base at C-Day + 1. Additionally, any one UTC may entail several hundred tons of cargo and just as many people, or a UTC could consist of one person. The task of prioritizing the cargo and personnel within these UTCs is given to the Installation Deployment Officer (IDO), for the deploying base. The IDO is responsible for overseeing all base deployment planning and execution.

Immediately following AEF II, the 1 FW organized an Initial Strike Package Airlift (ISPA) working group tasked with determining the requirements for the first seven days as well as the priority for those requirements. The working group completed this task for three different AEF scenarios.

1. lead unit, bare base
2. lead unit, main operating base
3. supporting unit, bare base or main operating base (10; 47:51)

34

A meeting between AMC and ACC planners resulted in a handshake agreement that the lead unit for an AEF deployment to a bare base would get two C-5s and two C-141s worth of airlift for ISPA. The dependent/supporting unit would receive one C-5 and one C-141 as their airlift for the ISPA. For the first scenario, the Langley working group surmised that 40 UTCs should be tasked. The second scenario consisted of 35 UTCs, and the third package was the smallest with 15 UTCs. The working group was able to build and prioritize an initial strike package that met the airlift constraint for all three scenarios (10).

General Looney's article, derived from his AEF II experience, *The Air Expeditionary Force*, is considered by some to be the definitive work in explaining the role, assumptions, and implementation process for an AEF (10). General Looney enumerated planning assumptions such as diplomatic clearances, overfly rights, host-nation base requirements, airlift requirements, and munitions constraints that must be reconciled (31:7-8). These assumptions are discussed further in Chapter III.

AEF III and AEF IV. AEFs III and IV may be grouped because the 4 FW at Seymour Johnson AFB, NC was the lead unit for both of these AEFs. Additionally, both of these deployments were to Doha, Qatar. In both cases Seymour Johnson sent 12 F-15Es. In AEF III the 33 FW, Eglin AFB sent 12 F-15Cs, and the 20 FW, Shaw AFB sent six F-15CJs. In addition, two B-52s were also deployed from the 2 BW at Barksdale AFB, LA. The AEF III deployment was conducted as a phased deployment not meant to validate the 72-hour requirement (8). Furthermore, AEF III participants started planning 90 days prior to the deployment. AEF III was handled as a rotational deployment to the AOR. The AEF III package was meant to be a replacement of forces in theatre for the

redeploying AEF II. The entire package for AEF III required approximately 44 C-141 equivalents to move and the deployed force was just short of 1100 personnel (33; 47:54-57).

The redeployment of AEF II fighters occurred as scheduled on 27 June 1996, just two days after the Khobar Towers bombing. AEF III fighters were deployed to the AOR during the first week of July, 1996. According to one source, the philosophy at the time was that each AEF would be deployed to one of five different locations (10). AEF I to Bahrain, AEF II to Jordan, and now AEF III and IV to Qatar. The other two locations have not hosted AEFs, to date. These locations were within the United Arab Emirates and Kuwait. The prevailing concept was that each AEF would be responsible for deploying with materials necessary to build up the infrastructure at each of the five locations. Upon termination of each AEF the infrastructure items would be stored in K-SPANS until another AEF was deployed to the same location (31:8-9). Additionally, the AEFs served as diplomatic envoys because the interactions between deployed USAF members and host nation personnel "were instrumental in increasing cooperation, understanding, and mutual admiration between our countries and our air forces" (31:9). This type of success would hopefully pave the way for obtaining diplomatic clearances quickly during future rapid AEF deployments in response to crisis in the region.

AEF III was deployed for six weeks versus the three-month AEF II deployment to Jordan. This was a return to the original AEF concept of deploying a force for 30-45 days. The shorter time-span eliminated many of the problems that arose due to sustainment operations; however, AEF IV was definitely a departure from this concept (8).

Due to political tensions with Iraq, AEF IV was deployed for four months. Beginning with the fourth AEF, the AEFs were no longer numbered sequentially. AEF IV was known as the 4 AEW, because the 4 FW was once again the lead unit to Doha, Qatar. The aircraft and locations of their participants in this deployment included: 12 F-16Cs from the 169 Fighter Group (FG) at McEntire ANGB and 12 F16CJs from the 20 FW at Shaw AFB, SC. This marked the first participation of a Guard or Reserve unit in an AEF deployment. The McEntire F-16s were replaced 45 days into the deployment by 12 F-16Cs from the 27 FW at Cannon AFB, NM. This AEF came closer to meeting the timing criterion than any other AEF (47:54-57).

The 4 FW had the benefit of already being deployed to Doha during AEF III. Planning for the 4 AEW deployment was accomplished by personnel who had actually deployed on AEF III. The deployment of the 4 AEW came just 7 months after the redeployment of AEF III. Many of the same host nation contractors would be used again during the 4 AEW deployment. In many ways, AEF III was used as a preparation for the 4 AEW. The deployment of the 4 AEW was supposed to be a good test to validate the timing criterion future AEWs would need to meet in response to crisis within the AOR. Seymour-Johnson in conjunction with AMC planners, had created a detailed plan to ensure the first few chalks would be expedited. This plan was known as the Mulvey plan (8; 32; 47:54-57).

Seymour-Johnson AFB's equivalent to the ISPA created by Langley is known as the Initial Combat Capability (ICC). Although Seymour-Johnson did not meet the criterion of generating sorties within 48 hours of the Execute Order they did come the closest of the AEF deployments. Seymour Johnson was able to generate sorties 72 hours

after the Execute Order was given. Prior to the Execute Order the 4 FW, 169 FG, and 20 FW had been in a state of Strategic Warning for 24 hours. However, the deployment timeline for the 4 AEW was artificial for two reasons. First, as stated, the 4 AEW was a scheduled deployment and wing personnel were aware of both the deployment location as well as the schedule for airlift. This information would not be available beforehand in a no-notice deployment. Second, the first airlifter arrived at L-hour (see Appendix B). In short, this means that there was a C-5 on the ground at Seymour Johnson at hour zero of the arbitrarily established Strategic Warning. According to AMC sources, this is not a realistic assumption for a no-notice AEW deployment (32).

AEF V. AEF V, or the 366 AEW, was the first AEF exclusively accomplished by one Air Force Base. The 366 WG at Mountain Home AFB deployed six F-15Cs, six F-15Es, ten F-16CJs, two KC-135Rs, and two B-1s. This was also the first AEW to include US Army assets in the deployment. The 11 Air Defense Artillery (ADA) from Fort Bliss, TX deployed a patriot missile battalion in support of the 366 AEW. The 366 AEW deployed to the same location as AEF I, Shaikh Isa, Bahrain. The ADA offered a force protection element to the deployed AEW that had not been present in previous AEFs. The deployed personnel for the 366 AEW numbered just over 1000 members (3; 11:2-20).

The 366 AEW was also a scheduled deployment. Personnel from the 366 WG were involved in numerous planning conferences before the actual deployment, and were given more than 30 days notification of the timing as well as the location of the deployment. The 366 AEW was used as both a Phase I and Phase II Operational Readiness Inspection. ACC/IG inspectors graded the deployment and generation phase

of this AEW. Additionally, ACC/IG inspectors were actually deployed to Bahrain to evaluate a Phase II scenario at the deployed location. According to one source, there was a full two-week delay between the departure of the first airlift aircraft and the arrival of the fighter package in theatre. This delay allowed virtually all cargo and personnel to be in place prior to the arrival of the fighters, rather than just the ICC (37).

The airlifters did not fly directly to Bahrain. Instead, all AMC aircraft made an enroute stop at Moron AB Spain. The 366 AEW fighters were deployed for approximately one month. This was a return to the original AEF CONOPS for deploying a force and redeploying before sustainment operations began at the 30-day point. The fighter package arrived in theatre on or about 15 September. The fighter arrival was followed by the arrival of the tankers and bombers within 3-5 days. The patriot battalion was the last force capability to meet closure (20; 37).

AEF VI. The sixth AEF was designated the 347 AEW. The 347 FW from Moody AFB was the lead unit for this AEF deployment to Bahrain. The 347 FW deployed 12 F-16Cs; the 33 FW at Eglin AFB, FL deployed 12 F-15Cs; and the 20 FW, Shaw AFB, SC deployed six F-16CJs. A patriot battalion was again deployed for this AEW. The deployment also included two B-1s and four KC-135s. The deployment of a bomber and tanker package, used in this AEW as well as both 366 AEWs, has become the new standard in deploying a cross-section of operational fire-power. This AEF/AEW, compared to each of the other AEFs, was the best validation of a no-notice scenario (3; 36).

The 347 AEW was deployed as a military response to Iraqi non-compliance with United Nations inspectors (30). The elapsed time between the Strategic Warning Order

and the Execute Order was 24 hours. During this time period, five C-5s landed at Moody AFB. The first C-5 was launched almost immediately following reception of the Execute Order. Moody completed its deployment of the ICC with the addition of one more C-5 for a total of six and one C-141. One of the Moody C-5s was forced to divert enroute to Bahrain due to mechanical problems. This C-5, full of ICC personnel and cargo, did not arrive before the fighter package (36).

The fighter aircraft deployed from Moody AFB were able to make the 48-hour criterion, however the tanker bridge was insufficient for Shaw's F-16CJs. The lack of tanker support forced Shaw F-16s to make an enroute stop at Lajes, Azores (30). The lack of a tanker bridge also caused delays in airlift. The final result was that the fighter package arrived at the deployed location piecemeal. In addition, the ICC was not completely in place before the fighters arrived (20).

AEF VII. The seventh USCENTAF AEF was the last accomplished prior to the publication of this research effort. As was the case in the sixth AEF deployment, the 366 WG was the lead unit and deployed all of the necessary aircraft. The package consisted of 12 F-15Cs, 12 F-15Es, 12 F-16CJs, two B-1s, and four KC-135Rs. The patriot battalion was deployed as well. The deployment was again designated the 366 AEW. Since the completion of this deployment in June 1998, the 366 FW has been designated as one of two rapid-response AEWs (22; 48).

The designation of Mountain Home AFB as a rapid-response AEW was due to their past AEF experience gained by participation in AEFs II, V, and VII. Additionally, Mountain Home AFB was designated with AEW on-call responsibility due to the advantages gained by deploying a composite wing to perform at a deployed location as a

composite force. One advantage is the pilots and crews of the different weapon systems are already accustomed to working together in a training environment. This should reap benefits in situations where an AEW is required and emphasis is placed on responsiveness (20; 35).

Another significant advantage of the composite wing is realized in the logistics support arena. Maintenance personnel assigned to Mountain Home AFB must be cognizant of requirements levied by each of the individual weapons systems. With inputs from these logistics experts, wing planners have a greater capability for pairing and tailoring the initial combat capability to ensure the minimum essential equipment is rapidly deployed. The evidence for this advantage of a composite force is corroborated by past AEFs. Lessons learned reports indicate that in many cases a surplus of equipment was deployed due to lack of communication between the maintenance personnel from the participating bases (33).

The second 366 AEW was deployed for three months. The Wing was notified 30 days before the deployment as to location and approximate timing. This AEW deployment was executed as a replacement for the 347 AEW at Bahrain. Once again, Strategic Warning was arbitrarily assigned and airlift was unrealistic to a stringent no-notice deployment. The seventh AEF was the largest deployment of personnel thus far, over 1200 personnel at its peak. Finally, the airlifters did not proceed directly to Bahrain, and this AEW did not meet the 72-hour criterion (20).

One piece of information not revealed by the examination of past AEF deployments was the origin of the 72-hour criterion. This researcher contacted HQ USAF/ILXX to determine the lineage for this criterion, but the AEF CONOPS authors

did not know the origin of the 72-hour criterion. The literature seems to indicate that prior to the deployment of AEF II, the timing criterion was to demonstrate operational effect within 48 hours of the issuance of an Execute Order. The conditional 24 hours of Strategic Warning was later added. No justification was found for the development of the current 72-hour criterion.

Deployment Timeline

Many of the activities involved in the deployment timeline of an AEW have already been discussed in this chapter. The AEW is deployed by AMC aircraft in two phases. The first phase of the deployment is known as the Initial Combat Capability (ICC). The ICC movement requirement is levied to AMC. ACC requires that the ICC be in place before the deploying fighters arrive in-theatre. Although the total package size has differed between AEF deployments due to combat jet makeup, the ICC makeup has remained somewhat standard. After the completion of AEF II, AMC apportioned the following airlift for the ICC (see Table 4). This is a total of 22 C-141 equivalents (C-5 = 3 C-141s & C-17 = 2 C-141s).

The deployment timeline is the compilation of those activities involved with deploying assets within the ICC. Figure 2 depicts an example of a timeline for an AEF. Each of the lines within this timeline represent one airlifter. The activities used to construct a model in this research project will resemble this timeline.

At any point on the deployment timeline, there may be several activities occurring simultaneously. Furthermore, simultaneously occurring activities may be the

responsibility of different organizations. An AEW deployment timeline is mostly

controlled by the actions of three separate organizations: the deploying Wing, AMC, and

the supported CINC. *AFP 10-417 USAF Deployment Management* describes many of the

Table 4. AMC Apportioned Airlift for AEF Deployments (11:2-21)

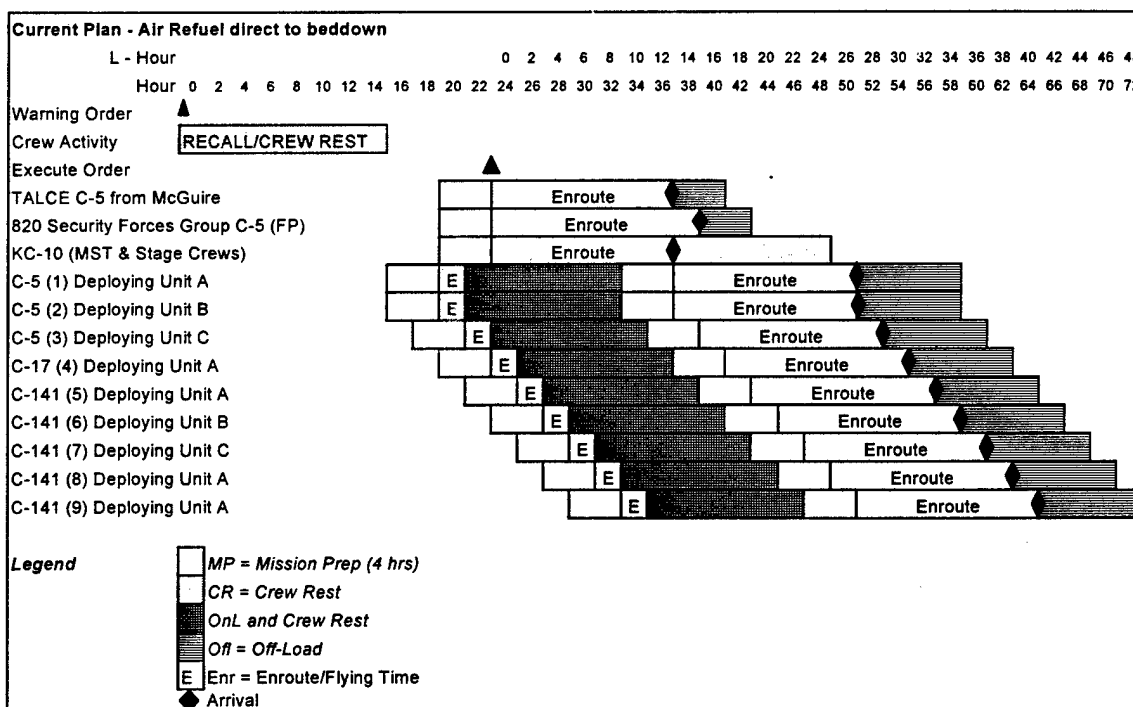| Reason	C-5	C-17	C-141
Lead Wing	1	1	3
Support Wing	1	0	1
Support Wing	1	0	1
Force Protect.	1	0	0
TALCE	1	0	0
Totals	5	1	5

Figure 2. AEF Timeline (11:2-22)

43

actions required for a deploying Wing in order to deploy personnel and cargo. Some of these actions include: recall, deployment briefing, assignment of cargo and personnel to specific airlift chalks, processing of personnel, cargo preparation for air worthiness, and cargo inspection (16:36). Although these events are necessary to the deployment of an AEW, they do not represent the critical path (3; 32). The critical path is "the chain of events through a project that sums to the greatest total time" (21:23).

According to ACC and AMC experts, the constraining factor of an AEW is the airlift and/or tanker support as well as the airfield throughput capacity (3; 32). These will be discussed in Chapter III. The events which are pertinent to the airlift portion of the timeline are: recall, crew rest, mission brief and pre-flight, flight times, cargo/personnel load times, cargo/personnel unload times, and ground times at enroute stops (32). The cargo and personnel load times are accomplished by wing personnel at the deploying base, in this case Mountain Home AFB.

After the ICC has been entirely delivered to the deployed location there are still events that must be accomplished according to the 72-hour criterion. First, the fighter aircraft must arrive and be regenerated. Regeneration involves a throughflight check, fueling of fighter aircraft, and munitions loading. Finally, the strike package must fly to the intended target (3). Together the ICC movement, fighter aircraft regeneration, and strike form the critical path to demonstrating AEW operational effect in 72 hours. This study focuses heavily on the movement of the ICC. The airlift portion of this movement is, as mentioned, assumed to be the critical path. The simultaneous deployment activities accomplished in parallel with the critical path are ignored in this research study. The

chain of key events comprising the critical path along with the assumptions inherent to the deployment timeline is discussed in more detail in Chapter III.

Summary

The AEW's ability to rapidly respond within 72-hours was not validated by past AEF deployments. This chapter discussed the significance of the AEF/AEW concept to NSS, NMS, deliberate planning, and crisis action planning. A brief overview of the AEW deployment timeline was also given to set the stage for the simulation phase of this research. The past AEF deployments were reviewed in this Chapter to develop the framework for the assumptions made in Chapter III.

The seven AEF deployments accomplished to date provide valuable insight into the concept of operations being developed for the AEW. Although each of the AEF deployments differed somewhat from the others there were similarities across several of the deployments. First, the current no-notice requirement was not present in any of the past AEF deployments. Instead, every deployment save one allowed for at least 30 days of planning to occur. Even the 347 AEF had more than the 24 hours of Strategic Warning called for by the stringent 72-hour criterion. Although diplomatic clearances and overfly rights were established for all of the AEF deployments, data was not available on the amount of time it took to obtain these clearances. As mentioned, the transportation requirement for the initial combat capability equipment and personnel has been somewhat established at around 22 C-141 equivalents. The AEFs have varied in the amount of time deployed from approximately 30 days to four months; however, most of

the AEF deployments were planned for a 30-day duration. The analysis of past AEF deployments accomplished in this chapter are referenced in the following chapters.

The following chapter describes the methodology of this research effort. Chapter IV presents the research findings and analysis. Finally, Chapter V provides the conclusions of this research effort.

III. Methodology

Introduction

This chapter discusses the experimental design and analytical methodology employed in this study. It begins by revisiting the management question, research objectives, and research questions set forth in Chapter I. Then the assumptions made for beginning objective one of the research objectives are presented. Next, the methodology and results of objectives one and two are presented in order to lay the groundwork for subsequent design-related issues. Finally, simulation modeling, used to accomplish objectives three and four, is presented and discussed as the most appropriate experimental tool for this study.

As stated in Chapter I, the objectives of this research were accomplished in four phases. The objectives of the research are geared towards answering the management question posed in Chapter I. The overarching problem is in quantifying the response time capability of an AEW. The question is whether the AEW can meet the 72-hour capability set by senior Air Force leadership. In order to meet these objectives research questions were presented. It is important at this point to restate those research questions.

1. What key events represent the critical path for the first 72 hours of an AEW deployment timeline?

2. What are the approximated distributions for each of the key events in this deployment timeline?

3. What is the current probability for completing an AEW in 72 hours?

4. What are the new probabilities for completing an AEW given changes in conceptual model assumptions to include: throughput capacity (i.e., increase in working maximum-on-ground), maintenance downtime due to airlift failures, and accomplishment of air-to-air refueling for all deploying airlifters?

Recall that research question one responds to research objective one, and so on. Furthermore, the results of accomplishing research objectives one and two were used as inputs to develop the simulation models used for objectives three and four. A baseline simulation model was developed to address research objective three. This model was altered in order to develop three different models to address research objective four. Each altered model deviated from the baseline model, and cumulative alterations were not accomplished. The key events representing the critical path for the first 72 hours of the AEW timeline along with the approximated distributions of these key events are also addressed in this chapter. In order to determine the key events representing the critical path for this timeline several assumptions were made. A listing and discussion of these assumption follows.

Assumptions

The assumptions presented in this section were gathered from a variety of sources. Mostly, the assumptions were gleaned from the review of literature accomplished in Chapter II. In some instances, assumptions were garnered from personal interviews with experts. Interviews were primarily conducted by use of telephone or electronic mail. Additionally, a visit to Scott AFB was accomplished in May 1999, where personal interviews were conducted with planning experts from HQ AMC/DOX. The purpose of these interviews was to develop assumptions not found in the literature, to

identify the key events comprising the critical path of an AEW deployment timeline, to approximate the distributions for the identified key events, and finally to assist in development of the conceptual model.

In some cases, it was necessary to reconcile assumptions, which differed between past AEF deployments. In other cases, assumptions had not yet been agreed upon by planning experts from different major commands. This reinforces that the AEW concept is a work in progress. The assumptions made for identifying the key events and eventually developing the simulation models may be found below. A complete discussion is included for each assumption. The discussion of each assumption includes: the reason for making the assumption; the source of the assumption; the impact, if pertinent, of the assumption on the deployment timeline; and dissenting opinions, if any, for the assumption. In order to comply with research objective four, assumptions 3, 7, and 13 were altered, and corresponding simulation models were developed. Included in the discussion of these three assumptions is the explanation of the alteration. The assumptions found below are not exhaustive nor do they represent all of the planning necessary for the undertaking of an AEW deployment. Instead, they represent the minimum list of assumptions necessary to provide the framework for identification of the deployment timeline critical path and eventually the construction of a valid simulation model.

Assumption 1: Diplomatic Clearances are not a Constraint. The ACC *CONOPS for a USCENTCOM AEF (Draft)* assumes "the necessary diplomatic clearances will be obtained either before Strategic Warning or within the 24-hour period between Strategic Warning and the Execute order" (2:12). This assumption is paramount to the success of

49

any deployment. Without diplomatic clearances an AEW is not a viable option for political decision-makers. This also assumes that overfly rights have been granted for airlifters, tankers, and fighters. An AEW could not meet the 72-hour criterion without both diplomatic clearances and overfly rights. Therefore this assumption lends itself towards achieving the 72-hour criterion.

Assumption 2: Deployment is to a Warm Base. This assumption may also be found in the ACC CONOPS. A warm base "at a minimum will include runway, water, special and some general purpose vehicles, POL, munitions, NAVAIDS and some means of expedient billeting" (2:12). This assumption dictates the need for base operating support capabilities contained within the initial combat capability (ICC) discussed in Chapter II.

Assumption 3: Air-Refueling Operations are not Accomplished on Deploying Airlifters. This assumption does not represent the current ACC philosophy (20). This assumption was made based on personal interviews with personnel from HQ AMC/DOX during a site visit to Scott AFB (32). At the time of this research, the *USAF Concept of Operations for AEF Implementation*, a product of HQ USAF, had not reconciled the disagreement over this assumption (15). According to AMC sources, refueling airlifters within the first 72 hours would require AMC to commit 110 aircraft and 135 aircrews. These numbers count each mission as an aircraft. AMC planning experts stated that the probability of providing this amount of support was low for the first 72 hours (32). Justification for this assumption can also be found in the review of past AEF deployments, accomplished in Chapter II.

The fighters will be air-refueled, and fly direct to the deployed location in this scenario. AMC experts stated that it would require at least 33 air-to-air refueling tankers to support the direct flight of the fighters.

The absence of air-refueling operations for AMC airlifters requires the use of enroute stops. The base used as an enroute stop in this research effort was Moron AB, Spain. This base was selected due to its use as an enroute stop for several of the past AEFs. Additionally, Moron is preferred as an enroute and staging base by AMC planners due to its robust capabilities (32). Airlifters are also required to make an enroute stop after departure from Mt. Home AFB, at Dover AFB, DE. Refueling operations and crew changes are performed at both Dover and Moron. This assumption detracts from the AEW's capability to meet the 72-hour requirement when compared to the ACC direct-flight philosophy.

The AEW working group assumption that air-to-air refueling is accomplished on deploying airlifters and its impact on AEW response capability is explored in this analysis. The baseline model assumption was altered to address research objective four by developing Model IV.

Assumption 4: Initial Combat Capability (ICC) Must be Completely Available Before Fighters Arrive. This assumption assumes that the equipment and personnel within the initial combat capability are necessary to conduct fighter-operations. The ICC is made up of assets directly related to supporting the fighter package or combat support forces, as well as base operating support equipment and personnel. An argument could be made that it is not essential to have the entire ICC in-place at the deployed location to regenerate arriving aircraft for the first strike. However ACC's position is that the ICC is

needed in-place before the jets arrive in order to: mitigate risk, provide infrastructure support, and to begin initial base operating support set-up (10; 35). This assumption acts to provide strict compliance to time-phasing of the AEW in the first 72 hours. If the ICC is not in-place before the scheduled arrival of the fighters, then the AEW has not met the 72-hour criterion. Recall from Chapter II that none of the AEWs met this assumption.

Assumption 5: Six C-17s and 3 C-5s are Sufficient for the ICC Movement Requirement. This assumption is actually two-fold. First, a simplifying assumption is made that the airlift mix is known. In reality, the aircraft mix for a no-notice deployment is unpredictable. AMC will provide airlift assets as available to accomplish the actual movement of troops and cargo. The impact of this particular airlift mix on the AEW's capability to meet the 72-hour criterion was not fully explored by this study. The C-141 was not considered for inclusion into the mix due to its limited carrying capacity, 20 short-tons, compared to the C-5, 65 short tons; and the C-17, 45 short-tons (32). Next, the mix of the C-5s and C-17s was developed based on a number of different factors to include: load times, reliability, and availability. Another airlift mix may lend itself towards increasing the AEW's capability to meet the 72-hour requirement; however it is just as likely that a airlift mix which decreases this same capability could present itself (32).

The second aspect of this assumption is that the given airflow is sufficient for the ICC movement requirement. Although the ICC is not fully developed by the AEW working group at Mountain Home AFB, the current philosophy of the working group is that nine airlifters will move the ICC. Colonel Duke validated the given airflow commenting that it should be sufficient to move the ICC (20). The ICC currently being

52

developed is for the Eagle package or 12 F-15Cs, 12 F-15Es, 12 F-16CJs, 4 B-1s, and 4 KC-135s (20). The airlift requirement may change based upon the outcome of the AEW working group.

Assumption 6: Tanker Air Lift Control Elements (TALCE), and Force Protection will be Deployed. This assumption was based on past AEFs as well as the interviews of both ACC and AMC planners. The movement of these capabilities adds four airlifters that must deploy prior to the deployment of Mountain Home AFB ICC assets. TALCEs (see Appendix B) must be deployed to the enroute location at Moron AB, Spain and the deployed location. Each of the TALCEs will be deployed utilizing a C-5. In addition, a force protection contingent will be deployed to the AEW location in accordance with AMC plans and past AEFs. The force protection group will be deployed on one C-5. Finally, a C-17 will carry additional maintenance equipment and stage crews to Moron AB. These capabilities are necessary to prepare for the arrival of AEW assets and airlift at both locations (3; 26; 32).

This assumption represents the minimum amount of airlift necessary for the AEW scenario. AMC experts indicated that the aircraft carrying Moron AB-bound cargo and personnel would remain at Moron AB. These aircraft would then be used as spares in case of AMC aircraft landing at Moron enroute to the deployed location (32). Therefore, changes would only increase airlift thereby, decreasing the capability of the AEW to meet the 72-hour criterion. This assumption is not altered during the development of models to address research objective four. The airlifters deployed to Moron AB in the baseline model are also deployed to Moron in the other models. Although no enroute stop is

required for the direct flight in the air refueling model, it is likely that AMC would still deploy assets to a European base such as Moron AB to prepare for possible diverts.

Assumption 7: Failures are not Considered. The reliability of AMC aircraft was not taken into consideration for research objective three. This was a simplifying assumption. This assumption lends itself towards the AEW meeting the 72-hour requirement because in reality failures do occur. AMC's use of spares at Moron AB is one method for combating the reality of failures. This assumption will be altered to assess its affect, during research objective four, on AEW response capability. The alteration for this assumption is discussed later in this chapter under Model III.

Assumption 8: No Notice. This scenario employs a simplifying assumption that there is no notice before the Strategic Warning Order is issued. Theoretically, this assumption is possible. A no-notice AEW deployment could occur during a scenario in which most of the steps of crisis action planning are skipped. As discussed in the crisis action planning section of Chapter II, a scenario, which required a flexible deterrent option, may also require rapid response. This study attempts to assess the AEW's capability to meet this worst-case scenario. AEW planners at the 366 WG AEW working group are currently working under a different assumption. Their efforts assume that there will be time to accomplish "left-of-the-line" planning (19; 20). This term assumes that a crisis will proceed through the stages of crisis action planning. This assumption represents the more likely scenario. The left-of-the-line planning concept holds that there will be time during the stages of crisis action planning to increase military readiness levels. With left-of-the-line planning some or all of the following actions could occur before the strategic warning: AMC crews could be recalled and put into crew rest, 366

54

WG personnel could be recalled, aircraft could be prepared for deployment, and cargo preparation actions would begin (19; 20). The model developed in this research effort assumes that no actions occur before the Strategic Warning Order.

Assumption 9: Mountain Home AFB, ID. This is a simplifying assumption. The 366 WG will be the deploying organization as one of two on-call rapid response AEWs.

Assumption 10: Strategic Warning Actions. This assumption acts to simplify the model development. It assumes that there is no delineation between the actions that may be taken during Strategic Warning and the actions taken after the Execute Order. In other words, events not usually accomplished prior to the issuance of the Execute Order may be accomplished. An example will serve to illustrate the impact of this assumption. If during the course of the deployment, an airlifter were completely loaded with cargo and personnel at Mountain Home AFB then, the airlifter would be allowed to deploy prior to the receipt of the Execution or Deployment Order. This assumption increases the likelihood of the AEW meeting the 72-hour criterion within the confines of the model.

Assumption 11: Munitions. The munitions required for arriving fighters are prepositioned at the deployed location. Intratheatre airlift assets may accomplish this. This has been the case for more than one of the past AEFs (31:8). Additionally, munitions build-up and storage areas are assumed to be available at the deployed location.

Assumption 12: Force Protection. Past AEFs have used force protection assets sourced from the deploying lead unit while others have used security forces from the Force Protection Battle Lab at Kelly AFB, TX (20). The force protection in this scenario

55

will be supplied from Dover AFB. This is a simplifying assumption which acts to increase the capability of the modeled AEW to meet the 72-hour criterion.

Assumption 13: Maximum-on-Ground (MOG). Several MOG assumptions were made to develop the two simulation models. The assumptions varied between the two simulation models. Two types of maximum on ground measures were used for the models; parking MOG and working MOG. Parking MOG refers to the maximum number of aircraft which can be physically accommodated on the airfield in question. Working MOG refers to the number of aircraft which can be simultaneously worked at one time, where "worked" refers to maintenance, load/offload operations, and aircraft fueling (12:5).

The first model assumes a working MOG of two for both Mountain Home AFB and the deployed location. This was based on the available Materiel Handling Equipment (MHE) at Mountain Home AFB and past AEF locations. This assumption is accepted by planners at AMC and ACC (20; 32). Additionally, the first model assumes parking MOGs of four at Mountain Home AFB and the deployed location in accordance with AMC assumptions (32). AMC experts were consulted in assuming a parking MOG of six for Moron AB for both models, and due to its capacity the parking MOG at Dover AFB was considered unlimited in the simulation model. Airlifters were not loaded/offloaded at Moron AB or Dover AFB; therefore, working MOGs were not applicable.

According to AMC and ACC planners the airfield throughput capability is a constraint for meeting the 72-hour AEW criterion (20 ; 32; 35). The working MOG is used in establishing the airflow schedule (see Assumption 15). As previously discussed, the working MOG constraint is relaxed for analysis in the second simulation model

developed to meet research objective four. Based on conversations with Colonel Duke, lead planner for the AEW working group, the working MOG was doubled to four at both Mountain Home AFB and the deployed location in the second model. The MOG relationship to throughput capability is illustrated by the following Air Mobility planning factor formula (12:5).

$$\text{Airfield Throughput Capability} = \frac{(MOG)(AveragePayload)(OperatingHours)}{(GroundTime)}(.85)$$

The parking MOGs were also increased to five at both the deployed location and Mountain Home AFB in the second model.

Assumption 14: Patriot Battalion Ignored. The patriot battalion may use initial airlift in the first 72 hours; however, a simplifying assumption was made to not include the Air Defense Artillery (ADA) in either model. This assumption was made due to the lack of definite guidance as to (ADA) time phasing.

Assumption 15: Airlift Flow Timing. The scheduled flow of airflow is dependent upon many variables. These include airfield throughput capability, aircrew availability, and airlift availability. Based on interviews with AMC planners, airflow schedules were built for all models. The models parallel reality in that AMC aircraft may not flow exactly as scheduled. The airlift flow for three of the four models assumes that the first six airlifters are scheduled at once. The first four airlifters, as mentioned, are dedicated to TALCE, AMC maintenance and aircrews, and force protection. The next two airlifters are sent to Mountain Home AFB for AEW movement. The last seven airlifters are

scheduled to arrive Mountain Home every two hours. The scheduled aircraft order after the first two aircraft (one C-5 and one C-17) for Mountain Home AFB is: C-17, C-17, C-5, C-17, C-17, C-17, C-5. This flow was developed to minimize the burden on Mountain Home AFB deployment personnel, as C-5s require more preparation time than C-17s (32).

The airlift flow for the relaxed working MOG constraint model (Model II) assumes that the first eight airlifters are scheduled at once. The same aircraft order is followed for this model; however, subsequent to the first four aircraft, airlift are scheduled to arrive Mountain Home AFB every hour.

Assumption 16: Crew Rest Waived to 12 Hours. The normal 16-hour crew rest requirement is waived to 12 hours for AMC crews. This is a standard assumption for time-critical deployments (32).

The preceding assumptions were developed in order to establish the framework for identifying the critical path key events on the AEW deployment timeline. The following section describes the identified key events.

Key Events Representing the Critical Path

This section describes the methodology and findings of research questions one and two. In order to identify the key events listed and described in this section various experts in AMC and ACC were consulted. Based on the proceeding assumptions consensus was reached during personal interviews with planning experts. Interviewees agreed that AMC aircraft are a resource constraint in the deployment arena. Given the no-notice assumption, outlined above, AMC planners agreed that airlifters could not be

deployed to Mountain Home AFB before wing personnel had processed cargo and personnel (32). ACC personnel stated that personnel and cargo could be available for deployment within 12 hours of strategic warning; however, AMC planners stated that, given the assumptions of this scenario, airlifters would not arrive at Mountain Home AFB before this 12 hour point (32; 35). Therefore, the events that would occur at Mountain Home AFB prior to the arrival of airlift are ignored for this analysis. Any event not specifically enumerated is assumed to occur in parallel with the critical path key events. The possibility that events comprising a non-critical path may in reality emerge as the critical path was not fully explored by this study.

The following paragraphs list and describe the key events, which are assumed by this study to comprise the critical path of the AEW deployment timeline. Included in the description of each key event is the source for approximating the distribution of time required for completing each of the events. The distribution parameters for each key event may be found in Table 5.

Key Event 1: Recall. The recall is accomplished immediately upon receipt of the Strategic Warning Order. During the recall AMC personnel are ordered into crew rest. This key event refers to the delay between receipt of the strategic warning and actual notification of all recalled aircrew-members. Planning experts at AMC/DOX approximated the probability distribution parameters for recall duration (32).

Key Event 2: Crew Rest. This event is required according to Air Force Instruction (AFI) 11-202V3. Recalled aircrews are put into crew rest in anticipation of an airlift mission. Crew rest "is the non-duty period before the flight duty period begins. Its purpose is to allow the aircrew member the opportunity for adequate rest before

59

performing in-flight duties" (14:42). Crew rest is a minimum of 12 hours. There was no distribution used for this key event.

Key Event 3: Mission Brief/Preflight. The mission brief/preflight times were treated as a single duration and did not have an associated distribution. This key event refers to those actions aircrews must accomplish in order to prepare for an airlift mission. These include; reviewing pertinent notices to airmen (NOTAMs), inspecting the airplane in accordance with aircraft specific technical orders, determining fueling requirements, insuring adequate fuel on-board, reviewing procedures and limitations, and mission planning. The times associated with this key event differed across types of airlifter. These times were supplied by AMC planners (14:8; 32).

Key Event 4: Flight Times. This is the amount of time airlift aircraft take to fly from one location to another. Flight times were approximated by use of the Joint Flow and Analysis System for Transportation (JFAST) flight time calculator. The parameters for the distribution associated with flight times were approximated by AMC planners. Flight times were allowed to vary by plus or minus half an hour on all legs except the direct flight from Mt. Home AFB to the deployed location used in Model IV. The optimistic/pessimistic parameters were plus and minus one hour respectively from the most likely duration on this leg due to the length of the flight. Dhahran, Saudi Arabia was used as the AEW deployed location for the purposes of flight time calculations only. Dhahran was used for this purpose due to its proximity to past AEF locations (32).

Key Event 5: Load/Unload Times. This key event refers to the time AMC aircraft encounter as a ground time for any loading or offloading mission at any airfield. Loading and offloading includes personnel and cargo. This time includes all actions taken by the

60

aircraft after landing to immediately before take-off. Times differed across different types of airlift. The respective load times were equal to the unload times within aircraft types. The mean for this key event time was given by Air Force Pamphlet 10-1403. The variance for this key event time was approximated by AMC (12; 32).

Key Event 6: Ground Times. During the course of the deployment timeline for three of the four developed models airlifters are required to make enroute stops at Dover AFB, DE and Moron AB, Spain. This key event accounts for the expired duration during these stops. As previously mentioned, enroute stops were not made in the air-refueling model (Model IV). It is assumed that each aircraft is fueled enroute stops and aircrews are swapped. The aircrews are swapped due to crew duty days limitations (32). Ground times for the baseline model (Model I) were approximated by AMC planners.

The ground time probability distribution was altered in order to simulate downtime in Model III, developed to address research objective four. This alteration entailed allowing airlifters to require maintenance during enroute stops. The alteration to this key event aligns with the alteration of assumption 7, previously discussed. The optimistic and most likely parameters for the ground time probability distribution used in Model III are the same as the baseline. The pessimistic parameter for this probability distribution was estimated by calculating an average of mean time-to-repair data for nine selected airlifter components (50:14). The inclusion of the pessimistic parameter in the probability distribution allowed for greater variance in airlifter ground times.

Key Event 7: Regeneration of Fighters. This time is not included in the actual simulation models. Currently, AEW planners are allocating six hours for the

61

regeneration time. This was the time duration used for this study. The concept assumes that four fighters from each group of 12 are regenerated (19; 20).

Key Event 8: Flight Time to Target. The flight time to target was also not included in the simulation model. AEW planners currently plan on a three-hour flight time. This research recognizes that flight times may vary greatly from scenario to scenario; however, three hours was used in this analysis.

The proceeding key events were used to construct a timeline for the AEW. Distributions were approximated for all events except crew rest duration, mission brief/preflight times, and fighter aircraft flight time-to-target. These events were treated as constants. Due to lack of actual data, interviewees were asked to provide an optimistic, pessimistic, and most likely time for each of the key events. This provided the parameters for the triangular distribution used in the simulation modeling. "The triangular distribution can be used when assumptions are made about the minimum, maximum, and modal values of the random variable" (6:196). The distributions for these events may be found in Tables 5 and 6.

The triangular distribution was also used due to its simplicity. This distribution was easily explained to interviewees when soliciting inputs for the parameters. Next, AMC planners were asked to develop a timeline based on the assumptions, limitations, and scope of this research scenario. AMC planners agreed that six airlifters would be deployed as soon as possible. The first six airlifters are utilized in the simulation models as reported in Table 7.

Table 5. Approximation of Key Event Time Distributions (hours).

Key Events	Minimum Time	Most Likely Time	Maximum Time
Recall	1	2	4
Crew Rest	12	12	12
Mission brief/ Preflight C-5	4	4	4
Mission brief/ Preflight C-17	3	3	3
Load C-5	2	4.25	5.25
Unload C-5	2	3.25	5.25
Load/unload C-17	1.75	2.25	3.25
Ground times (baseline)	2	3	4
Ground times (Model III)	2	3	7.15

Table 6. Calculated Flight Times (hours).

	Mountain Home AFB	Moron AB	Deployed Location
Airlift place of origin	4.5	Not applicable	Not applicable
Dover AFB	4.5	6.5	12.5
Deployed Location	17.5	6	Not applicable
Charleston AFB	4.5	7.8	Not applicable

Table 7. First Six Airlifters

Aircraft Type	Origin	Cargo	Destination
C-5	Dover AFB	TALCE	Moron AB, Spain
C-17	Charleston AFB	Maintenance assets Aircrews	Moron AB, Spain
C-5	Dover AFB	Force Protection	AEW location
C-5	Dover AFB	TALCE	AEW location
C-5	Travis AFB or Dover AFB	366 AEW personnel and equipment	AEW location
C-17	Charleston AFB	366 AEW personnel and equipment	AEW location

After this initial push of six airlifters, succeeding airlift will be scheduled to arrive

at Mountain Home AFB every two hours for three of the models and every hour under

the under the altered MOG model (Model II). As stated in the assumptions section, the

initial combat capability of the AEW package at Mountain Home AFB is transported by

six C-17s and 3 C-5s. Therefore, the cargo and personnel required for movement in the

first 72 hours of the AEW, are transported using six C-5s and 7 C-17s. Each of the

airlifters experiences its own combination of key events in order to transport cargo and

personnel to its designated location, either Moron AB or the deployed location. The

timelines for each individual airlifter are the 13 individual pieces, which make up the

deployment timeline, thus the conceptual model for this study. The process diagrams for

the baseline model (Model I) are illustrated in Figures 3, 4, 5, and 6. All airlifters

transporting Mountain Home AFB equipment and personnel follow the same process

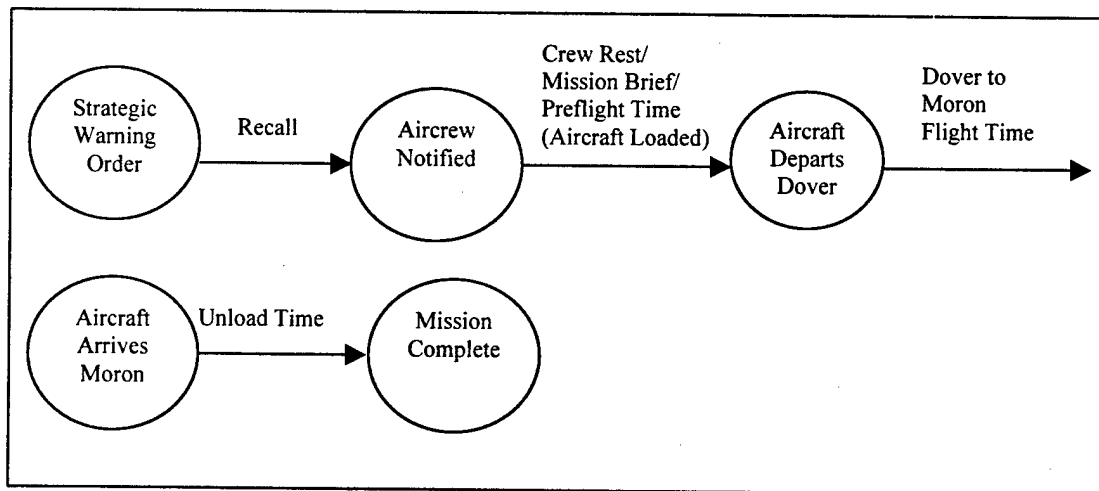diagram in each of the models except the air-refueling model (Model IV). The force

Figure 3. TALCE to Moron AB, Spain.

protection C-5 and the TALCE C-5 also adhere to the same process flow diagram across all models except Model IV. In both cases Model IV differs in that enroute stops at Moron and Dover are excluded.
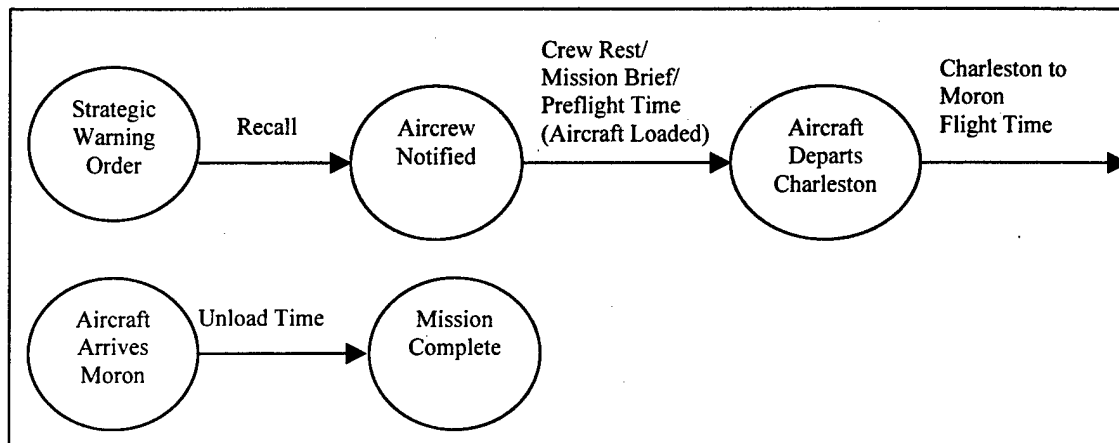

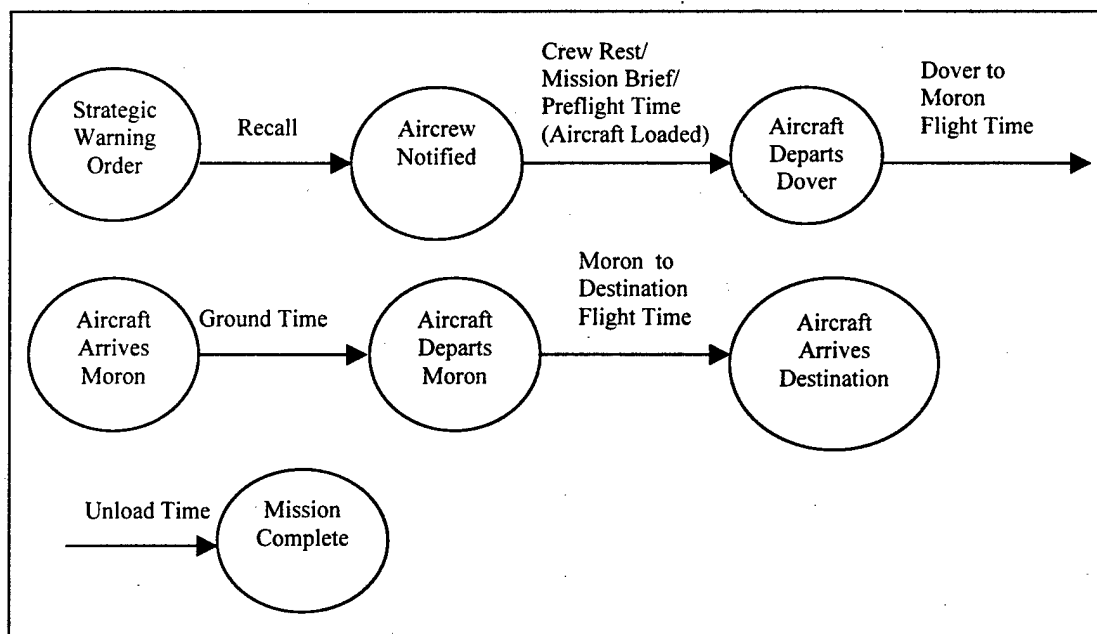**Figure 4. Maintenance and Stage Crew to Moron AB, Spain.**

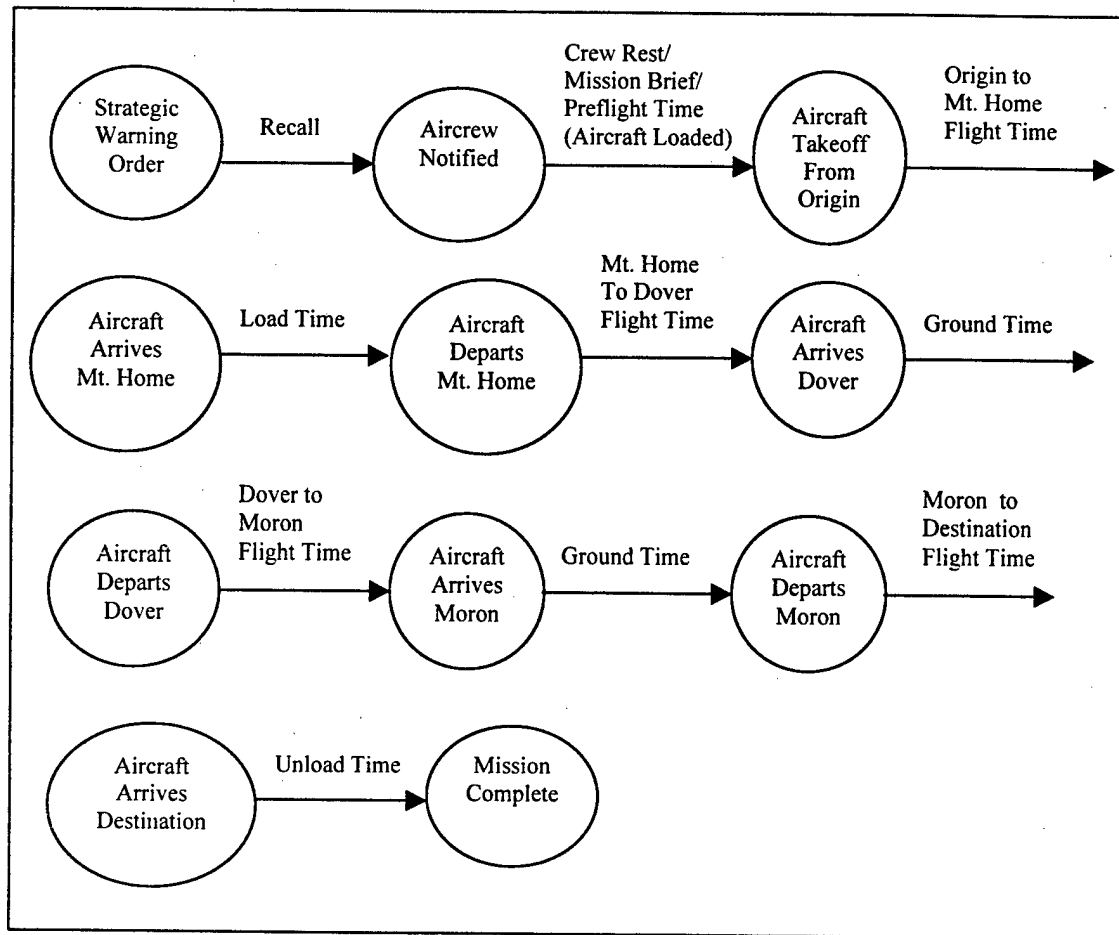**Figure 5. TALCE and Force Protection to Destination.**

Figure 6. AEW Personnel and Equipment to Destination.

Research Design

The research design was developed to answer research questions three and four.

The decision to use simulation as a tool in this research was based on the system

complexity inherent to the deployment timeline. Simulation is simply "the process of

designing a mathematical-logical model of a real system and experimenting with this

model on a computer" (39:6). Furthermore, "simulation enables the study of, and

experimentation with, the internal interactions of a complex system" (6:4). The use of

simulation also allows for the evaluation of new designs or polices prior to their implementation (6:4). This simulation modeling advantage enables this research to evaluate the effects of changing three model assumptions on the ability of the AEW to meet the 72-hour criterion. In order to accomplish a thorough and sound simulation study Banks, Carson, and Nelson have organized eleven steps to be followed (6:13-18).

1. *Problem Formulation.* Simply a clear statement of the problem
2. *Setting of Objectives and Overall Project Plan.* The objectives indicate which questions will be answered by the simulation. The project plan entails the cost of the study, number of people involved, and the time needed to accomplish the study.
3. *Model Conceptualization.* This step is the art of building a model of a system. This involves abstracting the essential features of a problem and selecting and modifying the basic assumptions that characterize the system.
4. *Data Collection.* This is the specification and collection of the inputs to the model.
5. *Model Translation.* The actual translation of the conceptual model into a computer recognizable format.
6. *Verification.* This is the process of establishing that the computer program is performing properly.
7. *Validation.* This is the process of ensuring the model is an accurate representation of the real system.
8. *Experimental Design.* This is the process of establishing the conditions required for actual model runs. This includes the length of simulation runs, number of runs, and initial conditions of the system under study.
9. *Production Runs and Analysis.* This step focuses on the actual running of the model as well as the subsequent analysis of model outputs to make inferences.
10. *Documentation and Reporting.* Documentation is the complete explanation of how the model was constructed. Reporting refers to the conveyance of the model results to others.
11. *Implementation.* This is the process of implementing decisions based upon the simulation.

Steps 1 and 2, problem formulation and setting overall objectives, have already been discussed at the beginning of this chapter as well as Chapter I. The problem for this simulation study was formulated in Chapter I with the management question. Likewise, the objectives and overall project plan were discussed in Chapter I and earlier in this

Chapter. Steps 3 and 4, model conceptualization and data acquisition have been discussed extensively in the previous sections of this chapter; however, a review of the four models is pertinent at this juncture.

Model I. This is the baseline model developed to address research objective three. It represents the original assumptions made in this research regarding an AEW deployment, the key deployment event times, and the event times distributions.

Model II. This is the first of three models developed to address research objective four. Each of the three models represented alterations to the baseline model. This particular simulation model was developed to assess the sensitivity of the dependent variable, probability of demonstrating operational effect in 72 hours or less, to a change in airfield throughput capacity at both Mountain Home AFB and the deployed location. The working MOG constraint was increased to a capacity of four airlifters based on current AEW working group assumptions.

Model III. This model was developed to assess the impact of including airlift reliability as a possible limiting factor on the dependent variable, probability of demonstrating operational effect in 72 hours or less. The pessimistic distribution parameter for airlift ground times was increased by 3.15 hours. Aircraft were only allowed to fail at the enroute locations. Furthermore, actual failures only occurred according to the random variate sampling of the discussed ground time distribution. This model attempted to inject the realism of mechanical failure into the modeled scenario.

Model IV. This model was developed to assess the sensitivity of the dependent variable, probability of demonstrating operational effect in 72 hours or less, to a change in the air-refueling assumption. Enroute stops at Dover and Moron were excluded in this

68

scenario. This model assumes that all airlift are air-refueled enroute to the deployed location. HQ USAF AEF CONOPS does not currently sanction the air-refueling assumption. Interviews revealed disagreement over this assumption between ACC and AMC planners.

Step 5, model translation, is covered by Appendix C, which provides the actual programming language for the simulation models used in this study. The conceptual model contained in Figures 3, 4, 5, and 6 as well as the approximated distributions for each key event were translated to computer code using Pritsker's AWESIM™ simulation software. The assumptions enumerated earlier in this chapter established the framework for model conceptualization. The resources used for the model were each base's parking maximum-on-ground as well as the working maximum on ground. There were five resources used in the model: Mountain Home AFB parking MOG, Moron AB parking MOG, deployed location parking MOG, Mountain Home AFB working MOG, and deployed location working MOG. These resources are discussed in the preceding assumptions section. Steps 6 and 7, verification and validation efforts respectively attempt to answer the questions: was the model built right and was the right model built?

Verification for the model used in this study was accomplished by using a number of different methods. The verification efforts are discussed in detail in Chapter IV. The validation effort was accomplished by use of an informal validation technique known as face validation. "Face validation is useful mostly as a preliminary approach to validation in the early stages of development" (17:4-3). This study may be considered an exploratory approach, since it is the first attempt at modeling the AEW timeline for the first 72 hours. AMC planning experts were asked during model construction whether

69

outputs were reasonable. Beyond consultation with experts it was difficult to compare outputs from the model with past AEF deployment times. This was due to the inconsistency of past AEF deployment conditions with the assumptions stated earlier in this chapter. The assumption having the largest impact on any attempted comparison between past AEF deployments and the model used in this study was the no-notice assumption.

Step 8, experimental design, has already been discussed to some extent in this chapter. First, the assumptions and key events, mentioned earlier, establish the initial conditions for the models. In order to determine the number of runs necessary two professors at the Air Force Institute of Technology were consulted. It was decided that at least 150 runs would be necessary to later approximate the output distribution for each model. Analysis, or step 9, was accomplished by using a software program known as Statistix™. Statistix was used to accomplish a Wilk-Shapiro test for normality on the resulting output data. Estimation of the probability distribution parameters was also accomplished utilizing Statistix. Once the distribution parameters were approximated an appropriate test was accomplished to determine the probability of deploying an AEW in less than 63 hours for each of the modeled scenarios (i.e., determining $P(X \leq 63$ hours), where X is a random variable describing the deployment time). The 63-hour value is obtained by subtracting the time to regenerate fighters (6 hours) and the time for fighters to fly to their targets (3 hours) for the 72-hour criterion.

Summary

This chapter presented the results from accomplishing research objectives 1 and 2. The assumptions and key event times established a framework for the simulation modeling research design. The first nine steps of simulation modeling were discussed in this chapter. The complete analysis of results will be presented in Chapter IV. Implementation, step 10, will be discussed in V. Finally, step 11, documentation and reporting is the purpose of this entire research effort; however, simulation model documentation may be found in Appendix C.

IV. Findings and Analysis

Chapter Overview

The simulation experiment described in Chapter III was designed expressly to answer research questions three and four. Likewise, the set of statistical tests employed was selected toward that end. The results from research questions one and two were presented in the previous chapter. To review, research questions three and four were presented in Chapter I.

3. What is the current probability for completing an AEW in 72 hours?

4. What are the new probabilities for completing an AEW given changes in conceptual model assumptions to include: throughput capacity (i.e., increase in working maximum-on-ground), maintenance downtime due to airlift failures, and accomplishment of air-to-air refueling for all deploying airlifters?

This chapter first presents verification efforts accomplished on the simulation models. Next, the statistical analyses accomplished on the simulation data as well as the results of these tests are presented.

Verification Efforts

Recall from Chapter III that verification deals with answering the question, *did I build the model right?* Verification for the model used in this study was accomplished by using a number of different methods. According to Banks and Carson, there are many procedures that may be followed in the verification process. First, they advise that the computerized representation be checked by someone other than its developer. This was accomplished by Major Alan Johnson a simulation modeling Professor at the Air Force Institute of Technology. Another suggestion from Banks and Carson was that a flow

diagram be created to document the model logic. This was accomplished in Chapter III in the four figures presented in Chapter III (6: 401).

In addition to the Banks and Carson suggestions, model construction was accomplished piece-wise for verification purposes. Each of the sub-processes were built individually and tested to verify accurate performance. Then the model was put together and tested as a whole. The number of airlifters for this deployment was equal to the number of entities used for the model. The model accurately allowed all thirteen entities to flow through the entire system. Next, the distributions were held to their minimum and maximum levels to establish a range across both models. Finally, the resources used in the model were decreased to ensure decreasing resources would affect the performance of the model. This was true, especially for the working MOG resources at both the deployed location and Mt. Home AFB. 150 runs were accomplished for both of the models for verification purposes.

Analysis

This section discusses the analysis performed on the simulation modeling output data. Additionally, the results of the analysis are presented. 150 runs of each model were accomplished. The data was then imported into Statistix for analysis.

Each data point represented the time required to successfully conduct an AEW deployment from issuance of Warning Order through unloading of the last airlifter transporting initial combat capability (ICC) equipment and personnel. Simulation model output provided the dependent variable in hours. Model I represented the baseline model of an AEW deployment with a working maximum-on-ground (MOG) constraint of two at

Mt. Home AFB and the deployed location. Model II represented an increase in the working maximum-on-ground constraint at Mt. Home AFB and the deployed location. A corresponding change in scheduled airflow to every hour was also present in Model II. Model III was developed to simulate limited aircraft failures and repair at the enroute locations. Finally, Model IV represents a change in the baseline assumption to simulate an AEW scenario in which all deploying airlifters are air-refueled. Each model run may be viewed as a separate AEW deployment. In order for each modeled AEW to meet the 72-hour criterion the resulting output must be 63 hours or less. As previously discussed, the 63 hours is the difference between the 72-hour criterion and the time to regenerate fighter aircraft (six hours) plus flight time to target (three hours), neither of which were included in the simulation models.

Wilk-Shapiro Test for Normality. The raw data from all models was imported into Statistix to determine whether or not the resulting probability distribution for each model output was normally distributed. The test accomplished to determine whether or not the simulation output data was normally distributed was the Wilk-Shapiro/Rankit plot test for normality. Using the Statistix program, the Wilk-Shapiro/Rankit Plot procedure determines whether a variable conforms to a normal distribution. In order to use the Wilk-Shapiro test for normality the data must be a random sample. This condition was met due to Awesim's use of random variates to generate values for all triangular distributed key deployment event times. A rankit plot of the variable was created, and an approximate Wilk-Shapiro normality statistic, the Shapiro-Francia statistic, is determined. According to Shapiro and Francia, *An Approximate Analysis of Variance Test for Normality*, when this statistic is at or above .967, the assumption of normality

74

holds true (43:215-216). The i-th rankit is defined as the expected value of the i-th order statistic for the sample, assuming the sample was from a normal distribution. The order statistics of a sample are the sample values reordered by their rank. If the sample conforms to a normal distribution, a plot of the rankits against the order statistics should result in a straight line, except for random variation. The approximate Wilk-Shapiro statistic calculated is the square of the linear correlation between the rankits and the order statistics. Systematic departure of the rankit plot from a linear trend indicates non-normality, as does a small value for the Wilk-Shapiro statistic. One or a few points departing from the linear trend near the extremes of the plot are indicative of outliers. (44:258-259). The Statistix rankit plots for each model may be found in Appendix D.

Test statistics of .989, .9879, .9933 and .9962 were calculated respectively for models I, II, III, and IV. Additionally, the rankit plots depict a straight-line relationship indicative of sample data from a normal distribution. Therefore, a normal probability distribution may be used to approximate the probability distributions for each set of data.

Parameters. Given that the sample data from each simulation run was normally distributed, the estimated parameters of the probability distribution were calculated for the corresponding data sets. The parameters for a normal distribution are the mean (μ) and standard deviation (σ). These parameters as well as the range for each probability distribution are depicted in Table 8.

Table 8. Model Parameters (hours)

	Mean (μ)	Standard Deviation (σ)	Range (Minimum)	Range (Maximum)
Model I	69.336	1.2932	66.681	72.7265
Model II	61.302	1.3243	58.512	64.979
Model III	71.431	1.9663	66.5	76.547
Model IV	63.660	1.368	60.306	66.908

Z-score Analysis. The parameters in Table 8 were used to determine the z-score

for meeting the 63-hour criterion. The area under the probability density curve to the left

of the 63-hour point is the probability of a successful AEW. The formula used to

calculate the z-score is: $z = \dfrac{(x - \mu)}{\sigma}$ where X = 63.

The z-score for the baseline AEW Model I was –4.90. The z-score for the AEW with

increased working maximum-on-ground constraint, Model II, was 1.28. The z-score for

the AEW with simulated downtime, Model III, was –4.29. Finally, the z-score for the

air-refueling scenario, Model IV, was -.58. These z-scores were used to determine the

$P(X \le 63$ hours). The $P(X \le 63)$ for Model I and Model III was interpolated to be

approximately 0. The $P(X \le 63)$ for Model II was calculated to be approximately .898.

Finally, the $P(X \le 63)$ for Model IV was calculated to be approximately .28. Quartiles

were also calculated for the data probability distributions as well. These quartiles are the

25th, 50th, and 75th percentiles of each data set. The value (X) given at each calculated

quartile (*i*) represents the random variable value at which the probability that the AEW

76

was accomplished at or below that value (x) is equal to *i*. These values may be found in

Table 9. The actual probability density functions may be found in Figure 7.

Table 9. Quartile Values (hours)

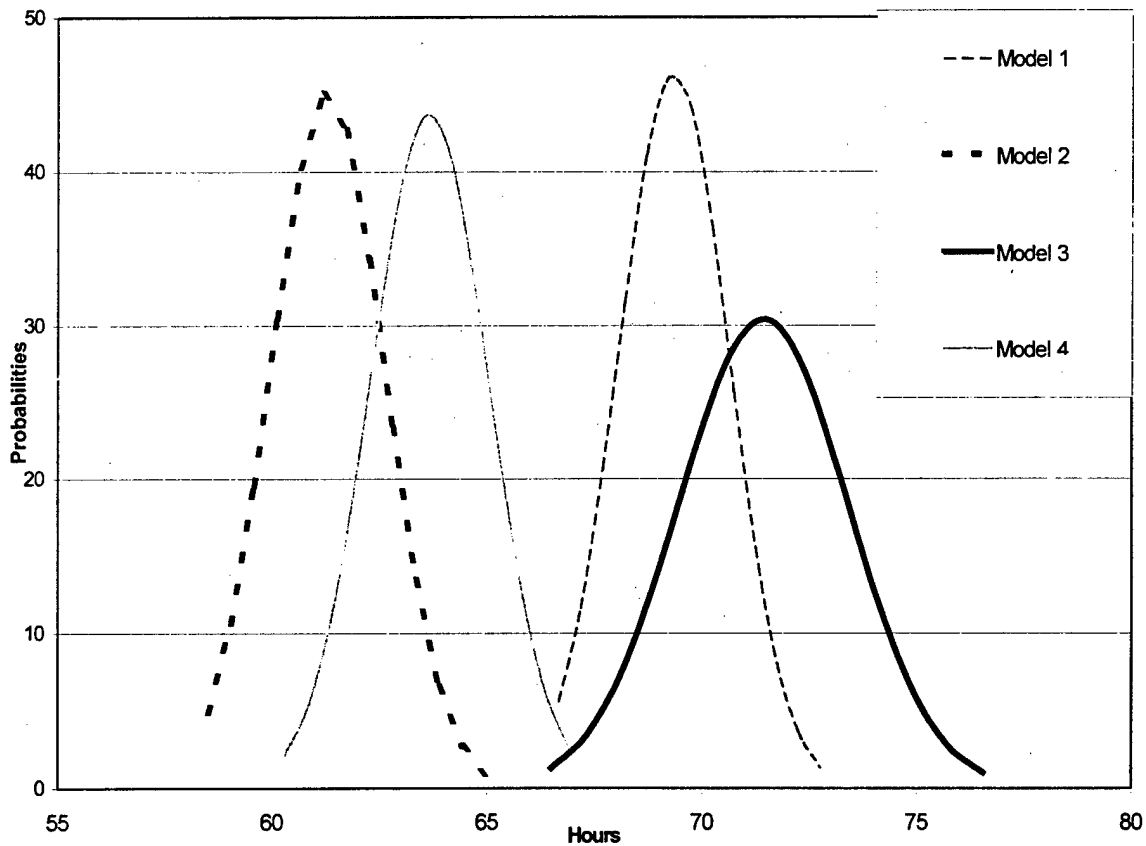|	25%	50%	75%
Model I	68.5	69.336	70.2
Model II	60.4	61.302	62.2
Model III	70.1	71.431	72.8
Model IV	62.9	63.660	64.4

Figure 7. Model Probability Density Functions

Summary

This chapter presented the results of statistical analysis accomplished on simulation model output. Additionally, the verification efforts used for model development were discussed. The results discussed above lead to the conclusions presented in Chapter V. Recommendations for future research are also discussed in Chapter V.

V. Conclusions and Recommendations

Introduction

This chapter concludes this study of the Air Expeditionary Wing responsiveness capability. First, the original research questions are revisited. Next, the conclusions reached for each of the research questions is discussed. The observations gained throughout the research effort are detailed with respect to Air Force implications. The tenth step of sound modeling and simulation, *implementation*, is briefly discussed. Throughout this chapter, limitations to this study are presented. Finally, recommendations for future researchers are provided.

Conclusions

Each of the four research questions from Chapter I is now restated and addressed based on the information contained in Chapters II through IV.

1. What key events represent the critical path for the first 72 hours of an AEW deployment timeline?

In Chapter II, a review of past AEF deployments was accomplished. This review provided a framework for the assumptions presented in Chapter III. The assumptions were used to isolate the key events comprising the critical path during the first 72 hours of an AEW deployment. Expert consultation was used to develop the assumptions, identify deployment timeline key events, and approximate the key event distribution times. The key events were common to each AMC airlifter transporting personnel and

equipment to the deployed location. Each of the key events used in this study were listed and defined within Chapter III.

The assumptions made in Chapter III were necessary to limit the scope of this study. The discussion of each assumption details dissenting opinions proffered by some planning experts consulted. In each case, justification for making the assumption was given. Collectively the assumptions are limitations to this research effort. As stated, the assumptions were used to identify those events which comprise the critical path of the AEW deployment timeline. Therefore, changes in assumptions may lead to the identification of new key events, and the development of a completely different simulation model. The key events identified in this study were: recall, crew rest, mission brief/preflight, aircraft loading, aircraft unloading, ground time, and flight time. In addition, constant duration times were used for fighter regeneration and fighter flight time-to-target. These times were not included in the simulation model; however, they were considered during the final analysis accomplished in Chapter IV.

The conceptual model used to develop the simulation model in this study was documented in the form of a process flow diagram (See Figures 3 through 6, Chapter III). The process flow diagram as well as the resulting simulation model attempted to model each of the 13 AMC aircraft. In order to actually run the model, distributions for the duration of each deployment key event time were approximated.

2. *What are the approximated distributions for each of the key events in the deployment timeline?*

The triangular distribution was used to approximate many of the key event times. Times were approximated through consultation with experts or in some cases by

80

referencing Air Force instructions. Flight times were approximated using the Joint Flow and Analysis System for Transportation (JFAST) flight time calculator. The actual parameters for approximated key event distributions may be found in Tables 5 and 6. The absence of actual data for the key event times required the utilization of the triangular distribution for simulation modeling; however, the lack of actual data is also a serious limitation to this study. Although experts provided the parameters (optimistic, pessimistic, and most likely times) for key event probability distributions, the actual key event times may adhere to a different distribution altogether. It is this researcher's opinion that parameters for actual key event time distributions are more pessimistic than those used in this study. Utilization of more pessimistic distribution parameters would increase the variance of each of the key event distributions. Furthermore, if the key event time durations are more pessimistic in reality than the actual probabilities for completing an AEW in 72 hours are less than indicated by this study.

3. What is the current probability for completing an AEW in 72 hours?

Research questions three and four were addressed through the use of simulation. The calculated probability for completing an AEW in 72 hours or less was approximately zero. Output from 150 runs of Model I was normally distributed. The 72-hour criterion (adjusted to 63 hours) fell almost five standard deviations below the estimated mean of the approximated normal distribution. The Empirical rule states that "approximately 99.7% (essentially all) of the measurements fall within 3 standard deviations of the mean" (34:70). This conclusion was based upon the assumptions and key event times identified in Chapter III, as well as the conceptual and simulation models discussed in

81

Chapters III and IV. Model I was treated as a baseline model from which alterations were made in order to address research question four.

4. *What are the new probabilities for completing an AEW given changes in conceptual model assumptions to include: throughput capacity (i.e., increase in working maximum-on-ground), maintenance downtime due to airlift failures, and accomplishment of air-to-air refueling for all deploying airlifters?*

The throughput capacity and air-refueling aspects of this research question were developed from ongoing work being accomplished by members of the 366 WG AEW working-group at Mountain Home AFB, Idaho. Colonel Gail Duke, Commander 366 Logistics Group, and AEW working-group chairperson, was interviewed for this thesis. The AEW working-group is working to ensure that the 366 rapid-response AEW can meet the 72-hour criterion. Many of the AEW working-group assumptions for AEW deployments were not completely in-line with the assumptions made for the baseline model. The differences in assumptions and justification for those differences are discussed in Chapter III.

One method for increasing AEW responsiveness capability is by increasing the airlift throughput capacity. Although the working MOG at Mountain Home AFB is currently two, Model II simulates an increase in the throughput capacity to a working MOG of four at both Mountain Home AFB and the deployed location. A new airflow was designed to accommodate this increase in throughput capability. The probability for completing an AEW in 72 hours or less for this second scenario was approximately 90%. The 72-hour criterion (adjusted to 63 hours) fell approximately 1.28 standard deviations above the estimated mean of the approximated normal distribution.

One difference between the assumptions made in the baseline model, and those proffered by the AEW working-group at Mt. Home was the air-refueling scenario. AEW working-group planners at Mt. Home accept this assumption; however, planners interviewed from HQ AMC did not concur with this assumption. Model IV incorporated the AEW working-group assumption, thus simulating air-refueling for all deploying airlifters. This departure from the baseline model acts as another method for increasing the responsiveness capability of the AEW. The probability of meeting the 72-hour criterion was greater for Model IV, approximately 28%, than Model I; however, responsiveness capability was less than Model II.

The probability distribution resulting from 150 runs of Model III had the largest mean of the four models. This was the only simulation model to incorporate failures of airlifters. Failures only occurred during ground times at enroute locations. The ground time for each airlifter was a result of sampling from a distribution with a range of 2-7.15 hours. The probability of the AEW represented by Model III of meeting the 72-hour criterion was approximated to be zero. The mean for this probability distribution was 4.29 standard deviations above the 72-hour criterion (adjusted to 63 hours).

This study did not address any plans for increasing working MOG at either Mountain Home AFB or the deployed location.

Implications and Limitations

General Ryan's recent announcement of his intentions to evolve the current Air Force to an Expeditionary Aerospace Force (EAF) brought credibility to USCENTAF's AEF concept (41). Along with 10 Air Expeditionary Forces the EAF concept will

include two on-call, rapid-response Air Expeditionary Wings. The on-call AEW

capability at Mountain Home AFB, the subject of this study, is currently developing their

Concept of Operations (CONOPS) for meeting a 72-hour criterion. The capability of the

on-call AEW is multi-dimensional. Two general capabilities of the AEW were discussed

in this study. The first, mission capability, was briefly discussed in Chapters I and II.

The mission capability of an AEW is a function of the sum of Unit Type Code

mission capabilities. The mission capability of an AEW is quantified in order to fulfill

supported Commander-in-Chief (CINC) requirements. Quantification of mission

capability seeks to answer CINC questions such as: *How much air superiority does an*

AEW give me? This study sought to assess another CINC capability-based question: *How*

long will it take? The answer to this question was termed responsiveness capability for

the purposes of this research. As stated, the current CONOPS requires that the AEW has

the responsiveness capability necessary to establish operational effect (put bombs on

target) in 72 hours or less. The combination of these two capabilities, mission and

responsiveness, has led the Air Force to define the AEF/AEW as a flexible deterrent

option (FDO). In fact, the AEF/AEW has been likened to another flexible deterrent

option, the carrier battle group.

The responsiveness capability of a carrier battle group is easily quantified as

being a function of distance from the fight. Additionally, the carrier battle group has

been used frequently in crisis response to project power or to gain forward presence.

Conversely, the stated AEF/AEW responsiveness capability has yet to be stringently

tested. This study assumed a worst-case crisis scenario in which the supported CINC

bypasses all phases of crisis action planning. In this case, an AEW may be required to

deploy with no-notice. According to the results of the baseline simulation model, an AEW would not meet the 72-hour criterion under the assumptions stated in Chapter III. Furthermore, when the air-refueling option is incorporated into Model IV the 72-hour criterion is met only 28% of the time. This implies that the Air Force is currently touting an inaccurate responsiveness capability to potential crisis response decision-makers such as CINC USCENTCOM, National Command Authority, and the Chairman, Joint Chiefs of Staff.

This study provided an example of one method for increasing the responsiveness capability of the AEW. A change in one assumption, the airlift throughput capacity, resulted in a 90% probability of an AEW meeting the 72-hour criterion. However, the resulting probability distributions and therefore the probability statements for Models I, II, and IV should be recognized as very forgiving towards completing the AEW in 72 hours given the worst-case no-notice scenario. The simulation models developed for this study are low fidelity due to the many complexities excluded. This was evidenced when one of the simplifying assumptions, no failures, was modified in Model III. The result, of course, was an increase in the dependent variable, mean time to complete the deployment of the initial combat capability. A more robust model incorporating additional fog and friction factors such as aircraft/mechanical failures, delays in information flow, miscommunications, personnel issues, and many other sources of delay may result in large increases to the dependent variable. Therefore, the mean of the respective probability distributions should be viewed as the minimum amount of time necessary to complete an actual AEW due to the limitations of the simulation models.

Based on input from experts in the field, this study was approached from a standpoint that AMC airlift is a resource constraint. This is a limiting factor for the response capability of the AEW when the initial combat capability (ICC) assumption described in Chapter III is considered. The results of this study may be discounted if this assumption is deemed unnecessary; however, the assumption that a certain amount of equipment and personnel must be in place before the fighter aircraft arrive was based on the CONOPS of each of the past seven AEF deployments. The improvement gained from changing the working-MOG constraint and the air-refueling assumption allowed improvements in the dependent variable, hours required for entire ICC movement. This implies that the Air Force may be able to determine where gains may be made in responsiveness capability by utilizing simulation methods. However, models with higher fidelity than those developed in this research are required in order to gain insight into the marginal utility of resource/policy changes on the responsiveness capability of the AEW.

The conclusions of this study were congruent with the results of a recently published article in the *Air Force Journal of Logistics*. Researchers from Rand corporation in cooperation with the Air Force Logistics Management Agency stated that in order to meet the deployment timeline criteria people must be deployed or material must be at an advanced state of preparation at the deployed location (45:38). This category-1 base defined in this article, *A Global Infrastructure to Support EAF*, was equal in capabilities to the warm-base used in this simulation. The equity in capabilities was achieved through the assumptions enumerated in Chapter III.

The tenth step of modeling and simulation is implementation. In this case, implementation would entail Air Force actions directed towards increasing the working

86

maximum-on-ground at Mountain Home AFB as well as the deployed location or ensuring that air-refueling is available for the initial AEW airlifters. This study, due to its exploratory nature, does not seek to make recommendations to that end. Instead, implementation should take the form of using simulations models such as the one utilized in this study to evaluate the effects of policy alternatives on AEW responsiveness capabilities. Policy alternatives may include decisions to increase fiscal spending on resources such as materials handling equipment or accelerated acquisition of the Air Force's newest airlifter, the C-17. Additionally, policy alternatives could entail changing the management philosophy of current resources by increasing readiness levels or re-positioning of war reserve materiel. Policy changes must be evaluated as to their costs and benefits. Simulation modeling is one tool for conducting such analysis.

One observation made during the qualitative portion of this research revealed that the initial AEW deployment is constrained in several different ways. Therefore improvements in one area may not decrease the overall time required to deploy the initial combat capability of the AEW. For example, an actual deployment of an AEW may see the working maximum-on-ground constraint improved from two to four, but diplomatic clearances not granted until 48 hours after the Warning Order. This example may be applied to other constraints such as, airlift/refueling tanker availability, prepositioned equipment, aircrew initial response, parking maximum-on-ground, fueling maximum-on-ground, host nation support, and aircraft reliabilities. This implies that implementation of policies designed to increase AEW responsive capability must be evaluated with respect to all of these possible constraining factors.

Recommendations to Future Researchers

Several areas surfaced during the course of this study, which lend themselves to follow-on research. The first of these deals with the crucial issue of improving the validity of the model. In order to quantify the exact response capability of the AEW the simulation model must be expanded. Secondly, assuming the development of a more robust and valid model, sensitivity analysis may be performed to assess the effects of changes to model inputs on the dependent variable (the time required to deploy the initial combat capability of the AEW). Finally, cost-benefit analysis of alternatives to improving AEW response capability should be accomplished prior to actually implementing policy changes.

Improvements to model validity, the first area for future research, may be accomplished by several different methods. The simplifying assumptions made to develop the model used in this study may be corrected in a more robust model. One simplifying assumption that could be modeled is mechanical failure of both the AMC aircraft as well as the failure rates of the fighter aircraft. Although Model III incorporated a probability of AMC aircraft failure at the enroute locations, a higher fidelity model would allow for aircraft failures and corresponding repair to occur at any point on the timeline. An expanded model may also attempt to incorporate probabilities associated with obtaining diplomatic clearance or overfly rights in a certain number of hours. Finally, future researchers may develop a model with key event time probability distribution parameters that have been approximated from actual deployment data rather than through use of personal interviews and the triangular distribution.

Future researchers should conduct sensitivity analysis in order to ascertain the effects of varying policy alternatives on AEW response improvements. Ideally, it would behoove future researchers to isolate the model inputs, which when changed, result in the largest improvements to the time required to deploy the AEW's initial combat capability. This study recommends analysis of several policy alternatives and the corresponding changes to simulation model inputs. One option would be to decrease the number of airlifters required due to increases in prepositioned war reserve materiel. Another would be to model a direct flight of varying levels of AMC airlift rather than abiding by the assumption incorporated into Model IV, that all deploying airlifters are air-refueled. Additional analysis could also be accomplished on varying levels of the working maximum-on-ground constraint due to acquisition of new materials handling equipment such as the *Tunner loader*. Sensitivity analysis could also be done to evaluate the effects of different mixes and orders of the airlift schedule. Finally, sensitivity analysis should be accomplished with regard to determining marginal utility of changes to model inputs, as previously mentioned. Researchers must quantify the effect of unit changes in model inputs to unit changes in the dependent variable, hours.

Detailed sensitivity analysis is not sufficient for making the optimum policy/resource decisions. In addition to developing a more valid model and accomplishing sensitivity analysis future researchers need to perform cost-benefit analysis. This study has presented the benefit, increased response capability, due to increases in the working maximum-on-ground constraint and inclusion of the air-refueling scenario. An extension to this study may perform cost-benefit analysis by determining the costs of increasing the working maximum-on-ground at Mountain Home

AFB and the deployed location. Similarly, a cost may be quantified for maintaining the AMC readiness levels required to ensure that a tanker bridge is in place for the AEW. Hypothetically, Air Force decision-makers may not be willing to commit to spending $20 million to increase the working MOG in order to improve the response time of the AEW by only seven hours. Cost-benefit analysis may be conducted on any of those areas mentioned in the sensitivity analysis recommendations.

Summary

The present study attempted to quantify the response capability of the AEW. Although seven AEF deployments have been accomplished in the Southwest Asia area of responsibility, none have met the stringent 72-hour criterion. Despite the inability of past AEF deployments to meet this criterion Air Force leadership maintains that the rapid-response AEW has the capability to meet this criterion. Simulation modeling has not been employed in past research to model the deployment process of an AEW in the first 72 hours. As such, many assumptions were necessary in order to develop the simulation models for this exploratory research. While necessary, these assumptions acted as a hindrance to model validity and fidelity. Analysis of results from the baseline AEW simulation model allowed this study to conclude that the AEW did not have the capability to meet the 72-hour criterion.

Additionally, this study examined the effect of three departures from the baseline model on responsiveness capability. These departures included: increasing airlift throughput capacity, incorporating limited airlift failure, and employing an air-refueling scenario. Based on the simulation model incorporating the increased airlift throughput

capacity, it was concluded that the AEW could meet the 72-hour criterion 90% of the time. The air-refueling simulation scenario met the 72-hour criterion 28% of the time. Finally, it was concluded that inclusion of potential downtime for AMC airlifters resulted in an AEW simulation model not capable of meeting the 72-hour criterion. The limitations of this study were discussed in the context of both the results and their implications, and future research was suggested towards quantifying policy/resource alternatives to assist senior Air Force decision-makers.

Appendix A: Acronyms

AB	Air Base
ACC	Air Combat Command
ADA	Air Defense Artillery
AEF	Air Expeditionary Force
AEW	Air Expeditionary Wing
AFB	Air Force Base
AFIT	Air Force Institute of Technology
AFP	Air Force Pamphlet
AMC	Air Mobility Command
AOR	Area of Responsibility
BPPBS	Biennial Planning, Programming, and Budgeting System
CAP	Crisis Action Planning
CINC	Commander in Chief
CJCS	Chairman, Joint Chiefs of Staff
COA	Course of Action
CONOPS	Concept of Operations
CONPLAN	Concept Plan
CONUS	Continental United States
CPA	Chairman's Program Assessment
DOD	Department of Defense
DPG	Defense Planning Guidance

EAF	Expeditionary Aerospace Force
FDO	Flexible Deterrent Option
FG	Fighter Group
FW	Fighter Wing
FYDP	Future Years Defense Plan
HARM	High-Speed Anti-Radiation Missile
HTS	HARM Targeting System
HQ	Headquarters
ICC	Initial Combat Capability
IDO	Installation Deployment Officer
IG	Inspector General
ISPA	Initial Strike Package Airlift
JFACC	Joint Force Air Component Commander
JFAST	Joint Flow and Analysis System for Transportation
JOPES	Joint Operation Planning and Execution System
JPD	Joint Planning Document
JPEC	Joint Planning and Execution Community
JSCP	Joint Strategic Capabilities Plan
JSOG	Joint Strategic Officer's Guide
JSPS	Joint Strategic Planning System
JSR	Joint Strategy Review
MHE	Materiel Handling Equipment
MISCAPS	Mission Capability Statements

MOG	Maximum-on-ground
MRE	Meals ready-to-eat
NAVAIDS	Navigational Aids
NCA	National Command Authority
NMCC	National Military Command Center
NMS	National Military Strategy
NOTAM	Notice to Airmen
NSCS	National Security Council System
NSS	National Security Strategy
OPLAN	Operational Plan
OPORD	Operation Order
PDM	Program Decision Memorandum
POL	Petroleum, Oil, and Lubricants
POM	Program Objective Memorandum
RDD	Required Delivery Dates
SEAD	Suppression of Enemy Air Defense
SECDEF	Secretary of Defense
SWA	Southwest Asia
TALCE	Tanker Air Lift Control Elements
TPFDD	Time-Phased Force and Deployment Data
USCENTAF	United States Central Air Force
USCENTCOM	United States Central Command
USTRANSCOM	United States Transportation Command

UTC	Unit Type Code
WMP	War and Mobilization Plan
WRM	War Reserve Materiel

Appendix B: Glossary of Terms

Area of Responsibility: The geographical area associated with a combatant command within which a combatant commander has authority to plan and conduct operations.

bare base: A base having a runway, taxiway(s), and parking area(s) which are adequate for the deployed force and possessing an adequate source of water that can be potable.

Commander in Chief: The terms "unified commander" and "specified commander" refers to commands established by the President as combatant commands under Section 161, United States Code. The acronym "CINC" refers to the commander of such a command.

crisis action planning: (DOD) 1. The Joint Operation Planning and Execution System process involving the time-sensitive development of joint operation plans and orders in response to an imminent crisis. Crisis action planning follows prescribed crisis action procedures to formulate and implement an effective response within the time frame permitted by the crisis. 2. The time-sensitive planning for the deployment, employment, and sustainment of assigned and allocated forces and resources that occurs in response to a situation that may result in actual military operations. Crisis action planners base their plan on the circumstances that exist at the time planning occurs. Also called CAP. See also Joint Operation Planning and Execution System.

concept of operations: (DOD) A verbal or graphic statement, in broad outline, of a commander's assumptions or intent in regard to an operation or series of operations. The concept of operations frequently is embodied in campaign plans and operation plans; in the latter case, particularly when the plans cover a series of connected operations to be carried out simultaneously or in succession. The concept is designed to give an overall picture of the operation. It is included primarily for additional clarity of purpose. Also called commander's concept.

course of action: (DOD) 1. A plan that would accomplish, or is related to, the accomplishment of a mission. 2. The scheme adopted to accomplish a task or mission. It is a product of the Joint Operation Planning and Execution System concept development phase. The supported commander will include a recommended course of action in the commander's estimate. The recommended course of action will include the concept of operations, evaluation of supportability estimates of supporting organizations, and an integrated time-phased data base of combat, combat support, and combat service support forces and sustainment. Refinement of this data base will be contingent on the time available for course of action development. When approved, the course of action becomes the basis for the development of an operation plan or operation order. Also called COA.

deliberate planning: (DOD) 1. The Joint Operation Planning and Execution System process involving the development of joint operation plans for contingencies identified in

joint strategic planning documents. Conducted principally in peacetime, deliberate planning is accomplished in prescribed cycles that complement other Department of Defense planning cycles in accordance with the formally established Joint Strategic Planning System. 2. A planning process for the deployment and employment of apportioned forces and resources that occurs in response to a hypothetical situation. Deliberate planners rely heavily on assumptions regarding the circumstances that will exist when the plan is executed. See also Joint Operation Planning and Execution System.

deterrent options: (DOD) A course of action, developed on the best economic, diplomatic, political, and military judgment, designed to dissuade an adversary from a current course of action or contemplated operations. (In constructing an operation plan, a range of options should be presented to effect deterrence. Each option requiring deployment of forces should be a separate force module.)

Expeditionary Aerospace Force (EAF). The EAF concept is how the Air Force will organize, train, equip, and sustain itself by creating a mindset and cultural state that embraces the unique characteristics of aerospace power – range, speed, flexibility, precision – to meet the national security challenges of the 21st century.

execute order: (DOD) 1. An order issued by the Chairman of the Joint Chiefs of Staff, by the authority and at the direction of the Secretary of Defense, to implement a National Command Authorities decision to initiate military operations. 2. An order to initiate military operations as directed.

flexible deterrent option: (DOD) A planning construct intended to facilitate early decision by laying out a wide range of interrelated response paths that begin with deterrent-oriented options carefully tailored to send the right signal. The Flexible Deterrent Option is the means by which the various deterrent options available to a commander (such as economic, diplomatic, political, and military measures) are implemented into the planning process. Also called FDO. See also deterrent options.

force module: (DOD) A grouping of combat, combat support, and combat service support forces, with their accompanying supplies and the required nonunit resupply and personnel necessary to sustain forces for a minimum of 30 days. The elements of force modules are linked together or are uniquely identified so that they may be extracted from or adjusted as an entity in the Joint Operation Planning and Execution System data bases to enhance flexibility and usefulness of the operation plan during a crisis. Also called FM. See also force module package.

Force Package. A Force Package is the basic unit designator of a unit type code (UTC) and is used as a planning tool to tailor an AEF.

Joint Operation Planning and Execution System: A continuously evolving system that is being developed through the integration and enhancement of earlier planning and execution systems: Joint Operation Planning System and Joint Deployment System. It

provides the foundation for conventional command and control by national- and theater-level commanders and their staffs. It is designed to satisfy their information needs in the conduct of joint planning and operations. Joint Operation Planning and Execution System (JOPES) includes joint operation planning policies, procedures, and reporting structures supported by communications and automated data processing systems. JOPES is used to monitor, plan, and execute mobilization, deployment, employment, and sustainment activities associated with joint operations. Also called JOPES.

Lead Unit: MAJCOMs designate a lead unit when the AEF forces placed on-call come from more than one location. The Lead Unit works closely with the parent MAJCOM who directs the planning and coordination efforts of designated AEF units to determine operational, logistics, and support requirements to meet mission objectives.

Maximum-on-Ground: The maximum number of aircraft that can be accommodated at one time at a specific location due to limitations of ramp space, servicing capabilities, cargo handling, or other considerations (MOG).

Mission Support Teams (MSTs): MSTs are smaller TALCE-like organizations that are generally capable of the same support TALCEs provide, only on a much smaller scale. They are generally led by a non-commissioned officer and provide a level of C2, aerial port, and maintenance services capable of supporting MOG of one aircraft.

Pre-Positioning: Pre-positioning refers to movements that take place prior to receipt of a CJCS Warning/Alert Order. Pre-positioning normally refers to equipment and supplies. *Exception:* The HQ AMC TACC commander may (pre)position air refueling forces (aircraft and crews) in anticipation of a Warning/Alert Order. Depending on the nature of the contingency, this will facilitate the timely movement of other positioning/deploying forces.

Reachback: This capability allows commanders to obtain or coordinate support from units not physically located with the forward force. By leveraging advances in communications technology, reachback capabilities make it possible to utilize CONUS and/or rear-based assets and organizations to perform various functions in support of AEF operations. Effective use of reachback will reduce the number of personnel and amount of equipment which deploys to the AOR, reduce airlift and support requirements, and will positively impact a commander's ability to protect the deployed force. Reachback is predicated on global communications, rapid global mobility, and time-definite resupply capabilities.

Tanker Airlift Control Elements (TALCE): A TALCE is a deployable C2 organization responsible for providing continuous on-site management of mobility airfield operations. It is a provisional organization composed of various mission support elements (MSE). TALCEs provide command, control, and communications, aerial port, logistics, maintenance, security, weather, medical, and intelligence services, as necessary. TALCEs are tailored based on projected requirements. TALCE's are designed to provide

immediate response capabilities in support of the deployment phase of a contingency. For sustainment operations, personnel sourced from mobility units should replace the TALCE. The TALCE then redeploys and reconstitutes for follow-on taskings.

time-phased force and deployment data: The Joint Operation Planning and Execution System data base portion of an operation plan; it contains time-phased force data, non-unit-related cargo and personnel data, and movement data for the operation plan, including: a. In-place units. b. Units to be deployed to support the operation plan with a priority indicating the desired sequence for their arrival at the port of debarkation. c. Routing of forces to be deployed. d. Movement data associated with deploying forces. e. Estimates of non-unit-related cargo and personnel movements to be conducted concurrently with the deployment of forces. f. Estimate of transportation requirements that must be fulfilled by common-user lift resources as well as those requirements that can be fulfilled by assigned or attached transportation resources. Also called TPFDD. See also time-phased force and deployment data maintenance; time-phased force and deployment data refinement; time-phased force and deployment list.

times: (DOD) (C-, D-, M-days end at 2400 hours Universal Time (zulu time) and are assumed to be 24 hours long for planning.) The Chairman of the Joint Chiefs of Staff normally coordinates the proposed date with the commanders of the appropriate unified and specified commands, as well as any recommended changes to C-day. L-hour will be established per plan, crisis, or theater of operations and will apply to both air and surface movements. Normally, L-hour will be established to allow C-day to be a 24-hour day.

> C-day. The unnamed day on which a deployment operation commences or is to commence. The deployment may be movement of troops, cargo, weapon systems, or a combination of these elements using any or all types of transport.
> L-hour. The specific hour on C-day at which a deployment operation commences or is to commence.
> D-day. The unnamed day on which a particular operation commences or is to commence.
> H-hour. The specific hour on D-day at which a particular operation commences.

unit type code: (DOD) A five-character, alphanumeric code that uniquely identifies each type unit of the Armed Forces. Also called UTC

warning order: (DOD) A crisis action planning directive issued by the Chairman, Joint Chiefs of Staff that initiates the development and evaluation of courses of action by a supported commander and requests that a commander's estimate be submitted.

war reserves: (DOD, NATO) Stocks of materiel amassed in peacetime to meet the increase in military requirements consequent upon an outbreak of war. War reserves are intended to provide the interim support essential to sustain operations until resupply can be effected.

Appendix C: AWESIM Program Code

Model I

```
 1 GEN,,"AEF",19Jun,150,YES,YES;
 2 LIMITS,,,,2;
 3 INITIALIZE,0.0,45000,YES;
 4 NETWORK,READ;
 5 FIN;
 1 RESOURCE,3,Daharan,4,{3};
 2 RESOURCE,2,Moron,6,{2};
 3 RESOURCE,1,Mt_Home,4,{1};
 4 RESOURCE,4,Load,2,{4};
 5 RESOURCE,5,Unload,2,{5};
 6 CREATE,INF,0.0,,1,1;
 7 ACTIVITY,,TRIAG(1,2,4)+16,,,,"Notify Crews";
 8 Takeoff1: GOON,1;
 9 ACTIVITY,,TRIAG(6,6.5,7);
10 ALTER,2,-1,1;
11 ACTIVITY,,TRIAG(2,3.25,5.25);
12 ALTER,2,+1,1;
13 ACTIVITY,,,,"terminate";
14 CREATE,INF,0.0,,1,1;
15 ACTIVITY,,TRIAG(1,2,4)+15,,,,"Notify Crews";
16 Takeoff2: GOON,1;
17 ACTIVITY,,TRIAG(7.3,7.8,8.3);
18 ALTER,2,-1,1;
19 ACTIVITY,,TRIAG(1.75,2.25,3.25);
20 ALTER,2,+1,1;
21 ACTIVITY,,,,"terminate";
22 CREATE,INF,0.0,,1,1;
23 ACTIVITY,,TRIAG(1,2,4)+16,,,,"Notify Crews";
24 Takeoff3: GOON,1;
25 ACTIVITY,,TRIAG(6,6.5,7);
26 ALTER,2,-1,1;
27 ACTIVITY,,TRIAG(2,3,4);
28 ALTER,2,+1,1;
29 ACTIVITY,,TRIAG(5.5,6,6.5),,"SecForc";
30 SecForc: ALTER,3,-1,1;
31 ACTIVITY;
32 AWAIT,,{{5,1}},ALL,,NONE,1;
33 ACTIVITY,,TRIAG(2,3.25,5.25);
34 FREE,{{5,1}},1;
35 ACTIVITY;
36 ALTER,3,+1,1;
```

```
37 ACTIVITY,,,,"terminate";
38 CREATE,INF,0.0,,1,1;
39 ACTIVITY,,TRIAG(1,2,4)+16,,,,"Notify Crews";
40 Takeoff4: GOON,1;
41 ACTIVITY,,TRIAG(6,6.5,7);
42 ALTER,2,-1,1;
43 ACTIVITY,,TRIAG(2,3,4);
44 ALTER,2,+1,1;
45 ACTIVITY,,TRIAG(5.5,6,6.5),,"TALCE";
46 TALCE: ALTER,3,-1,1;
47 ACTIVITY;
48 AWAIT,,{{5,1}},ALL,,NONE,1;
49 ACTIVITY,,TRIAG(2,3.25,5.25);
50 FREE,{{5,1}},1;
51 ACTIVITY;
52 ALTER,3,+1,1;
53 ACTIVITY,,,,"terminate";
54 CREATE,8,TRIAG(1,2,4),,3,1;
55 ACTIVITY,,16,,,,"Notify Crews";
56 AWAIT,,{{1,1}},ALL,,NONE,1;
57 ACTIVITY;
58 FREE,{{1,1}},1;
59 ACTIVITY,,TRIAG(4,4.5,5);
60 ALTER,1,-1,1;
61 ACTIVITY;
62 AWAIT,,{{4,1}},ALL,,NONE,1;
63 ACTIVITY,,TRIAG(2,4.25,5.25);
64 FREE,{{4,1}},1;
65 ACTIVITY;
66 ALTER,1,+1,1;
67 ACTIVITY,,TRIAG(4,4.5,5),,"Chalk159";
68 Chalk159: GOON,1;
69 ACTIVITY,,TRIAG(2,3,4);
70 AWAIT,,{{2,1}},ALL,,NONE,1;
71 ACTIVITY;
72 FREE,{{2,1}},1;
73 ACTIVITY,,TRIAG(6,6.5,7);
74 ALTER,2,-1,1;
75 ACTIVITY,,TRIAG(2,3,4);
76 AWAIT,,{{3,1}},ALL,,NONE,1;
77 ACTIVITY;
78 FREE,{{3,1}},1;
79 ACTIVITY;
80 ALTER,2,+1,1;
81 ACTIVITY,,TRIAG(5.5,6,6.5);
```

```
82 ALTER,3,-1,1;
83 ACTIVITY,,,,"Chalk159cont";
84 Chalk159cont: AWAIT,,{{5,1}},ALL,,NONE,1;
85 ACTIVITY,,TRIAG(2,3.25,5.25);
86 FREE,{{5,1}},1;
87 ACTIVITY;
88 ALTER,3,+1,1;
89 ACTIVITY,,,,"terminate";
90 CREATE,2,TRIAG(1,2,4),,3,1;
91 ACTIVITY,,15,,,,"Notify Crews";
92 AWAIT,,{{1,1}},ALL,,NONE,1;
93 ACTIVITY;
94 FREE,{{1,1}},1;
95 ACTIVITY,,TRIAG(4,4.5,5);
96 ALTER,1,-1,1;
97 ACTIVITY;
98 AWAIT,,{{4,1}},ALL,,NONE,1;
99 ACTIVITY,,TRIAG(1.75,2.25,3.25);
100 FREE,{{4,1}},1;
101 ACTIVITY;
102 ALTER,1,+1,1;
103 ACTIVITY,,TRIAG(4,4.5,5),,"Chalk234";
104 Chalk234: GOON,1;
105 ACTIVITY,,TRIAG(2,3,4);
106 AWAIT,,{{2,1}},ALL,,NONE,1;
107 ACTIVITY;
108 FREE,{{2,1}},1;
109 ACTIVITY,,TRIAG(6,6.5,7);
110 ALTER,2,-1,1;
111 ACTIVITY,,TRIAG(2,3,4);
112 AWAIT,,{{3,1}},ALL,,NONE,1;
113 ACTIVITY;
114 FREE,{{3,1}},1;
115 ACTIVITY;
116 ALTER,2,+1,1;
117 ACTIVITY,,TRIAG(5.5,6,6.5);
118 ALTER,3,-1,1;
119 ACTIVITY,,,,"Chalk234cont";
120 Chalk234cont: AWAIT,,{{5,1}},ALL,,NONE,1;
121 ACTIVITY,,TRIAG(1.75,2.25,3.25);
122 FREE,{{5,1}},1;
123 ACTIVITY;
124 ALTER,3,+1,1;
125 ACTIVITY,,,,"terminate";
126 CREATE,2,10,,3,1;
```

```
127 ACTIVITY,,15,,,,"Notify Crews";
128 AWAIT,,{{1,1}},ALL,,NONE,1;
129 ACTIVITY;
130 FREE,{{1,1}},1;
131 ACTIVITY,,TRIAG(4,4.5,5);
132 ALTER,1,-1,1;
133 ACTIVITY;
134 AWAIT,,{{4,1}},ALL,,NONE,1;
135 ACTIVITY,,TRIAG(1.75,2.25,3.25);
136 FREE,{{4,1}},1;
137 ACTIVITY;
138 ALTER,1,+1,1;
139 ACTIVITY,,TRIAG(4,4.5,5),,"Chalk678";
140 Chalk678: GOON,1;
141 ACTIVITY,,TRIAG(2,3,4);
142 AWAIT,,{{2,1}},ALL,,NONE,1;
143 ACTIVITY;
144 FREE,{{2,1}},1;
145 ACTIVITY,,TRIAG(6,6.5,7);
146 ALTER,2,-1,1;
147 ACTIVITY,,TRIAG(2,3,4);
148 AWAIT,,{{3,1}},ALL,,NONE,1;
149 ACTIVITY;
150 FREE,{{3,1}},1;
151 ACTIVITY;
152 ALTER,2,+1,1;
153 ACTIVITY,,TRIAG(5.5,6,6.5);
154 ALTER,3,-1,1;
155 ACTIVITY,,,,"Chalk678cont";
156 Chalk678cont: AWAIT,,{{5,1}},ALL,,NONE,1;
157 ACTIVITY,,TRIAG(1.75,2.25,3.25);
158 FREE,{{5,1}},1;
159 ACTIVITY;
160 ALTER,3,+1,1;
161 ACTIVITY,,,,"terminate";
162 terminate: GOON,1;
163 ACTIVITY;
164 COLCT,,TNOW,,,,,1;
165 ACTIVITY;
166 TERMINATE,13;
```

Model II

```
1 GEN,,"AEF",19Jun,150,YES,YES;
2 LIMITS,,,,2;
3 INITIALIZE,0.0,45000,YES;
```

```
4 NETWORK,READ;
5 FIN;
1 RESOURCE,5,Unload,4,{5};
2 RESOURCE,4,Load,4,{4};
3 RESOURCE,1,Mt_Home,5,{1};
4 RESOURCE,2,Moron,6,{2};
5 RESOURCE,3,Daharan,5,{3};
6 CREATE,INF,0.0,,1,1;
7 ACTIVITY,,TRIAG(1,2,4)+16,,,,"Notify Crews";
8 Takeoff1: GOON,1;
9 ACTIVITY,,TRIAG(6,6.5,7);
10 ALTER,2,-1,1;
11 ACTIVITY,,TRIAG(2,3.25,5.25);
12 ALTER,2,+1,1;
13 ACTIVITY,,,,"terminate";
14 CREATE,INF,0.0,,1,1;
15 ACTIVITY,,TRIAG(1,2,4)+15,,,,"Notify Crews";
16 Takeoff2: GOON,1;
17 ACTIVITY,,TRIAG(7.3,7.8,8.3);
18 ALTER,2,-1,1;
19 ACTIVITY,,TRIAG(1.75,2.25,3.25);
20 ALTER,2,+1,1;
21 ACTIVITY,,,,"terminate";
22 CREATE,INF,0.0,,1,1;
23 ACTIVITY,,TRIAG(1,2,4)+16,,,,"Notify Crews";
24 Takeoff3: GOON,1;
25 ACTIVITY,,TRIAG(6,6.5,7);
26 ALTER,2,-1,1;
27 ACTIVITY,,TRIAG(2,3,4);
28 ALTER,2,+1,1;
29 ACTIVITY,,TRIAG(5.5,6,6.5),,"SecForc";
30 SecForc: ALTER,3,-1,1;
31 ACTIVITY;
32 AWAIT,,{{5,1}},ALL,,NONE,1;
33 ACTIVITY,,TRIAG(2,3.25,5.25);
34 FREE,{{5,1}},1;
35 ACTIVITY;
36 ALTER,3,+1,1;
37 ACTIVITY,,,,"terminate";
38 CREATE,INF,0.0,,1,1;
39 ACTIVITY,,TRIAG(1,2,4)+16,,,,"Notify Crews";
40 Takeoff4: GOON,1;
41 ACTIVITY,,TRIAG(6,6.5,7);
42 ALTER,2,-1,1;
43 ACTIVITY,,TRIAG(2,3,4);
```

```
44 ALTER,2,+1,1;
45 ACTIVITY,,TRIAG(5.5,6,6.5),,"TALCE";
46 TALCE: ALTER,3,-1,1;
47 ACTIVITY;
48 AWAIT,,{{5,1}},ALL,,NONE,1;
49 ACTIVITY,,TRIAG(2,3.25,5.25);
50 FREE,{{5,1}},1;
51 ACTIVITY;
52 ALTER,3,+1,1;
53 ACTIVITY,,,,"terminate";
54 CREATE,4,TRIAG(1,2,4),,3,1;
55 ACTIVITY,,16,,,,"Notify Crews";
56 AWAIT,,{{1,1}},ALL,,NONE,1;
57 ACTIVITY;
58 FREE,{{1,1}},1;
59 ACTIVITY,,TRIAG(4,4.5,5);
60 ALTER,1,-1,1;
61 ACTIVITY;
62 AWAIT,,{{4,1}},ALL,,NONE,1;
63 ACTIVITY,,TRIAG(2,4.25,5.25);
64 FREE,{{4,1}},1;
65 ACTIVITY;
66 ALTER,1,+1,1;
67 ACTIVITY,,TRIAG(4,4.5,5),,"Chalk159";
68 Chalk159: GOON,1;
69 ACTIVITY,,TRIAG(2,3,4);
70 AWAIT,,{{2,1}},ALL,,NONE,1;
71 ACTIVITY;
72 FREE,{{2,1}},1;
73 ACTIVITY,,TRIAG(6,6.5,7);
74 ALTER,2,-1,1;
75 ACTIVITY,,TRIAG(2,3,4);
76 AWAIT,,{{3,1}},ALL,,NONE,1;
77 ACTIVITY;
78 FREE,{{3,1}},1;
79 ACTIVITY;
80 ALTER,2,+1,1;
81 ACTIVITY,,TRIAG(5.5,6,6.5);
82 ALTER,3,-1,1;
83 ACTIVITY,,,,"Chalk159cont";
84 Chalk159cont: AWAIT,,{{5,1}},ALL,,NONE,1;
85 ACTIVITY,,TRIAG(2,3.25,5.25);
86 FREE,{{5,1}},1;
87 ACTIVITY;
88 ALTER,3,+1,1;
```

89 ACTIVITY,,,,"terminate";
90 CREATE,1,TRIAG(1,2,4),,3,1;
91 ACTIVITY,,15,,,,"Notify Crews";
92 AWAIT,,{{1,1}},ALL,,NONE,1;
93 ACTIVITY;
94 FREE,{{1,1}},1;
95 ACTIVITY,,TRIAG(4,4.5,5);
96 ALTER,1,-1,1;
97 ACTIVITY;
98 AWAIT,,{{4,1}},ALL,,NONE,1;
99 ACTIVITY,,TRIAG(1.75,2.25,3.25);
100 FREE,{{4,1}},1;
101 ACTIVITY;
102 ALTER,1,+1,1;
103 ACTIVITY,,TRIAG(4,4.5,5),,"Chalk234";
104 Chalk234: GOON,1;
105 ACTIVITY,,TRIAG(2,3,4);
106 AWAIT,,{{2,1}},ALL,,NONE,1;
107 ACTIVITY;
108 FREE,{{2,1}},1;
109 ACTIVITY,,TRIAG(6,6.5,7);
110 ALTER,2,-1,1;
111 ACTIVITY,,TRIAG(2,3,4);
112 AWAIT,,{{3,1}},ALL,,NONE,1;
113 ACTIVITY;
114 FREE,{{3,1}},1;
115 ACTIVITY;
116 ALTER,2,+1,1;
117 ACTIVITY,,TRIAG(5.5,6,6.5);
118 ALTER,3,-1,1;
119 ACTIVITY,,,,"Chalk234cont";
120 Chalk234cont: AWAIT,,{{5,1}},ALL,,NONE,1;
121 ACTIVITY,,TRIAG(1.75,2.25,3.25);
122 FREE,{{5,1}},1;
123 ACTIVITY;
124 ALTER,3,+1,1;
125 ACTIVITY,,,,"terminate";
126 CREATE,1,5,,3,1;
127 ACTIVITY,,15,,,,"Notify Crews";
128 AWAIT,,{{1,1}},ALL,,NONE,1;
129 ACTIVITY;
130 FREE,{{1,1}},1;
131 ACTIVITY,,TRIAG(4,4.5,5);
132 ALTER,1,-1,1;
133 ACTIVITY;

```
134 AWAIT,,{{4,1}},ALL,,NONE,1;
135 ACTIVITY,,TRIAG(1.75,2.25,3.25);
136 FREE,{{4,1}},1;
137 ACTIVITY;
138 ALTER,1,+1,1;
139 ACTIVITY,,TRIAG(4,4.5,5),,"Chalk678";
140 Chalk678: GOON,1;
141 ACTIVITY,,TRIAG(2,3,4);
142 AWAIT,,{{2,1}},ALL,,NONE,1;
143 ACTIVITY;
144 FREE,{{2,1}},1;
145 ACTIVITY,,TRIAG(6,6.5,7);
146 ALTER,2,-1,1;
147 ACTIVITY,,TRIAG(2,3,4);
148 AWAIT,,{{3,1}},ALL,,NONE,1;
149 ACTIVITY;
150 FREE,{{3,1}},1;
151 ACTIVITY;
152 ALTER,2,+1,1;
153 ACTIVITY,,TRIAG(5.5,6,6.5);
154 ALTER,3,-1,1;
155 ACTIVITY,,,,"Chalk678cont";
156 Chalk678cont: AWAIT,,{{5,1}},ALL,,NONE,1;
157 ACTIVITY,,TRIAG(1.75,2.25,3.25);
158 FREE,{{5,1}},1;
159 ACTIVITY;
160 ALTER,3,+1,1;
161 ACTIVITY,,,,"terminate";
162 terminate: GOON,1;
163 ACTIVITY;
164 COLCT,,TNOW,,,,,1;
165 ACTIVITY;
166 TERMINATE,13;
```

Model III

```
 1 GEN,,"AEF",19Jun,150,YES,YES;
 2 LIMITS,,,,2;
 3 INITIALIZE,0.0,45000,YES;
 4 NETWORK,READ;
 5 FIN;
 1 RESOURCE,5,Unload,2,{5};
 2 RESOURCE,4,Load,2,{4};
 3 RESOURCE,1,Mt_Home,4,{1};
 4 RESOURCE,2,Moron,6,{2};
 5 RESOURCE,3,Daharan,4,{3};
```

```
 6 CREATE,INF,0.0,,1,1;
 7 ACTIVITY,,TRIAG(1,2,4)+16,,,,"Notify Crews";
 8 Takeoff1: GOON,1;
 9 ACTIVITY,,TRIAG(6,6.5,7);
10 ALTER,2,-1,1;
11 ACTIVITY,,TRIAG(2,3.25,5.25);
12 ALTER,2,+1,1;
13 ACTIVITY,,,,"terminate";
14 CREATE,INF,0.0,,1,1;
15 ACTIVITY,,TRIAG(1,2,4)+15,,,,"Notify Crews";
16 Takeoff2: GOON,1;
17 ACTIVITY,,TRIAG(7.3,7.8,8.3);
18 ALTER,2,-1,1;
19 ACTIVITY,,TRIAG(1.75,2.25,3.25);
20 ALTER,2,+1,1;
21 ACTIVITY,,,,"terminate";
22 CREATE,INF,0.0,,1,1;
23 ACTIVITY,,TRIAG(1,2,4)+16,,,,"Notify Crews";
24 Takeoff3: GOON,1;
25 ACTIVITY,,TRIAG(6,6.5,7);
26 ALTER,2,-1,1;
27 ACTIVITY,,TRIAG(2,3,7.15);
28 ALTER,2,+1,1;
29 ACTIVITY,,TRIAG(5.5,6,6.5),,"SecForc";
30 SecForc: ALTER,3,-1,1;
31 ACTIVITY;
32 AWAIT,,{{5,1}},ALL,,NONE,1;
33 ACTIVITY,,TRIAG(2,3.25,5.25);
34 FREE,{{5,1}},1;
35 ACTIVITY;
36 ALTER,3,+1,1;
37 ACTIVITY,,,,"terminate";
38 CREATE,INF,0.0,,1,1;
39 ACTIVITY,,TRIAG(1,2,4)+16,,,,"Notify Crews";
40 Takeoff4: GOON,1;
41 ACTIVITY,,TRIAG(6,6.5,7);
42 ALTER,2,-1,1;
43 ACTIVITY,,TRIAG(2,3,7.15);
44 ALTER,2,+1,1;
45 ACTIVITY,,TRIAG(5.5,6,6.5),,"TALCE";
46 TALCE: ALTER,3,-1,1;
47 ACTIVITY;
48 AWAIT,,{{5,1}},ALL,,NONE,1;
49 ACTIVITY,,TRIAG(2,3.25,5.25);
50 FREE,{{5,1}},1;
```

```
51 ACTIVITY;
52 ALTER,3,+1,1;
53 ACTIVITY,,,,"terminate";
54 CREATE,8,TRIAG(1,2,4),,3,1;
55 ACTIVITY,,16,,,,"Notify Crews";
56 AWAIT,,{{1,1}},ALL,,NONE,1;
57 ACTIVITY;
58 FREE,{{1,1}},1;
59 ACTIVITY,,TRIAG(4,4.5,5);
60 ALTER,1,-1,1;
61 ACTIVITY;
62 AWAIT,,{{4,1}},ALL,,NONE,1;
63 ACTIVITY,,TRIAG(2,4.25,5.25);
64 FREE,{{4,1}},1;
65 ACTIVITY;
66 ALTER,1,+1,1;
67 ACTIVITY,,TRIAG(4,4.5,5),,"Chalk159";
68 Chalk159: GOON,1;
69 ACTIVITY,,TRIAG(2,3,7.15);
70 AWAIT,,{{2,1}},ALL,,NONE,1;
71 ACTIVITY;
72 FREE,{{2,1}},1;
73 ACTIVITY,,TRIAG(6,6.5,7);
74 ALTER,2,-1,1;
75 ACTIVITY,,TRIAG(2,3,7.15);
76 AWAIT,,{{3,1}},ALL,,NONE,1;
77 ACTIVITY;
78 FREE,{{3,1}},1;
79 ACTIVITY;
80 ALTER,2,+1,1;
81 ACTIVITY,,TRIAG(5.5,6,6.5);
82 ALTER,3,-1,1;
83 ACTIVITY,,,,"Chalk159cont";
84 Chalk159cont: AWAIT,,{{5,1}},ALL,,NONE,1;
85 ACTIVITY,,TRIAG(2,3.25,5.25);
86 FREE,{{5,1}},1;
87 ACTIVITY;
88 ALTER,3,+1,1;
89 ACTIVITY,,,,"terminate";
90 CREATE,2,TRIAG(1,2,4),,3,1;
91 ACTIVITY,,15,,,,"Notify Crews";
92 AWAIT,,{{1,1}},ALL,,NONE,1;
93 ACTIVITY;
94 FREE,{{1,1}},1;
95 ACTIVITY,,TRIAG(4,4.5,5);
```

```
96 ALTER,1,-1,1;
97 ACTIVITY;
98 AWAIT,,{{4,1}},ALL,,NONE,1;
99 ACTIVITY,,TRIAG(1.75,2.25,3.25);
100 FREE,{{4,1}},1;
101 ACTIVITY;
102 ALTER,1,+1,1;
103 ACTIVITY,,TRIAG(4,4.5,5),,"Chalk234";
104 Chalk234: GOON,1;
105 ACTIVITY,,TRIAG(2,3,7.15);
106 AWAIT,,{{2,1}},ALL,,NONE,1;
107 ACTIVITY;
108 FREE,{{2,1}},1;
109 ACTIVITY,,TRIAG(6,6.5,7);
110 ALTER,2,-1,1;
111 ACTIVITY,,TRIAG(2,3,7.15);
112 AWAIT,,{{3,1}},ALL,,NONE,1;
113 ACTIVITY;
114 FREE,{{3,1}},1;
115 ACTIVITY;
116 ALTER,2,+1,1;
117 ACTIVITY,,TRIAG(5.5,6,6.5);
118 ALTER,3,-1,1;
119 ACTIVITY,,,,"Chalk234cont";
120 Chalk234cont: AWAIT,,{{5,1}},ALL,,NONE,1;
121 ACTIVITY,,TRIAG(1.75,2.25,3.25);
122 FREE,{{5,1}},1;
123 ACTIVITY;
124 ALTER,3,+1,1;
125 ACTIVITY,,,,"terminate";
126 CREATE,2,10,,3,1;
127 ACTIVITY,,15,,,,"Notify Crews";
128 AWAIT,,{{1,1}},ALL,,NONE,1;
129 ACTIVITY;
130 FREE,{{1,1}},1;
131 ACTIVITY,,TRIAG(4,4.5,5);
132 ALTER,1,-1,1;
133 ACTIVITY;
134 AWAIT,,{{4,1}},ALL,,NONE,1;
135 ACTIVITY,,TRIAG(1.75,2.25,3.25);
136 FREE,{{4,1}},1;
137 ACTIVITY;
138 ALTER,1,+1,1;
139 ACTIVITY,,TRIAG(4,4.5,5),,"Chalk678";
140 Chalk678: GOON,1;
```

```
141 ACTIVITY,,TRIAG(2,3,7.15);
142 AWAIT,,{{2,1}},ALL,,NONE,1;
143 ACTIVITY;
144 FREE,{{2,1}},1;
145 ACTIVITY,,TRIAG(6,6.5,7);
146 ALTER,2,-1,1;
147 ACTIVITY,,TRIAG(2,3,7.15);
148 AWAIT,,{{3,1}},ALL,,NONE,1;
149 ACTIVITY;
150 FREE,{{3,1}},1;
151 ACTIVITY;
152 ALTER,2,+1,1;
153 ACTIVITY,,TRIAG(5.5,6,6.5);
154 ALTER,3,-1,1;
155 ACTIVITY,,,,"Chalk678cont";
156 Chalk678cont: AWAIT,,{{5,1}},ALL,,NONE,1;
157 ACTIVITY,,TRIAG(1.75,2.25,3.25);
158 FREE,{{5,1}},1;
159 ACTIVITY;
160 ALTER,3,+1,1;
161 ACTIVITY,,,,"terminate";
162 terminate: GOON,1;
163 ACTIVITY;
164 COLCT,,TNOW,,,,,1;
165 ACTIVITY;
166 TERMINATE,13;
```

Model IV

```
 1 GEN,,"AEF",19Jun,150,YES,YES;
 2 LIMITS,,,,2;
 3 INITIALIZE,0.0,45000,YES;
 4 NETWORK,READ;
 5 FIN;
 1 RESOURCE,5,Unload,2,{5};
 2 RESOURCE,4,Load,2,{4};
 3 RESOURCE,1,Mt_Home,4,{1};
 4 RESOURCE,2,Moron,6,{2};
 5 RESOURCE,3,Daharan,4,{3};
 6 CREATE,INF,0.0,,1,1;
 7 ACTIVITY,,TRIAG(1,2,4)+16,,,,"Notify Crews";
 8 Takeoff1: GOON,1;
 9 ACTIVITY,,TRIAG(6,6.5,7);
10 ALTER,2,-1,1;
11 ACTIVITY,,TRIAG(2,3.25,5.25);
12 ALTER,2,+1,1;
```

```
13 ACTIVITY,,,,"terminate";
14 CREATE,INF,0.0,,1,1;
15 ACTIVITY,,TRIAG(1,2,4)+15,,,,"Notify Crews";
16 Takeoff2: GOON,1;
17 ACTIVITY,,TRIAG(7.3,7.8,8.3);
18 ALTER,2,-1,1;
19 ACTIVITY,,TRIAG(1.75,2.25,3.25);
20 ALTER,2,+1,1;
21 ACTIVITY,,,,"terminate";
22 CREATE,INF,0.0,,1,1;
23 ACTIVITY,,TRIAG(1,2,4)+16,,,,"Notify Crews";
24 Takeoff3: GOON,1;
25 ACTIVITY,,TRIAG(12,12.5,13);
26 SecForc: ALTER,3,-1,1;
27 ACTIVITY;
28 AWAIT,,{{5,1}},ALL,,NONE,1;
29 ACTIVITY,,TRIAG(2,3.25,5.25);
30 FREE,{{5,1}},1;
31 ACTIVITY;
32 ALTER,3,+1,1;
33 ACTIVITY,,,,"terminate";
34 CREATE,INF,0.0,,1,1;
35 ACTIVITY,,TRIAG(1,2,4)+16,,,,"Notify Crews";
36 Takeoff4: GOON,1;
37 ACTIVITY,,TRIAG(12,12.5,13);
38 TALCE: ALTER,3,-1,1;
39 ACTIVITY;
40 AWAIT,,{{5,1}},ALL,,NONE,1;
41 ACTIVITY,,TRIAG(2,3.25,5.25);
42 FREE,{{5,1}},1;
43 ACTIVITY;
44 ALTER,3,+1,1;
45 ACTIVITY,,,,"terminate";
46 CREATE,8,TRIAG(1,2,4),,3,1;
47 ACTIVITY,,16,,,,"Notify Crews";
48 AWAIT,,{{1,1}},ALL,,NONE,1;
49 ACTIVITY;
50 FREE,{{1,1}},1;
51 ACTIVITY,,TRIAG(4,4.5,5);
52 ALTER,1,-1,1;
53 ACTIVITY;
54 AWAIT,,{{4,1}},ALL,,NONE,1;
55 ACTIVITY,,TRIAG(2,4.25,5.25);
56 FREE,{{4,1}},1;
57 ACTIVITY;
```

```
58 ALTER,1,+1,1;
59 ACTIVITY,,TRIAG(16.5,17.5,18.5);
60 ALTER,3,-1,1;
61 ACTIVITY,,,,"Chalk159cont";
62 Chalk159cont: AWAIT,,{{5,1}},ALL,,NONE,1;
63 ACTIVITY,,TRIAG(2,3.25,5.25);
64 FREE,{{5,1}},1;
65 ACTIVITY;
66 ALTER,3,+1,1;
67 ACTIVITY,,,,"terminate";
68 CREATE,2,TRIAG(1,2,4),,3,1;
69 ACTIVITY,,15,,,,"Notify Crews";
70 AWAIT,,{{1,1}},ALL,,NONE,1;
71 ACTIVITY;
72 FREE,{{1,1}},1;
73 ACTIVITY,,TRIAG(4,4.5,5);
74 ALTER,1,-1,1;
75 ACTIVITY;
76 AWAIT,,{{4,1}},ALL,,NONE,1;
77 ACTIVITY,,TRIAG(1.75,2.25,3.25);
78 FREE,{{4,1}},1;
79 ACTIVITY;
80 ALTER,1,+1,1;
81 ACTIVITY,,TRIAG(16.5,17.5,18.5);
82 ALTER,3,-1,1;
83 ACTIVITY,,,,"Chalk234cont";
84 Chalk234cont: AWAIT,,{{5,1}},ALL,,NONE,1;
85 ACTIVITY,,TRIAG(1.75,2.25,3.25);
86 FREE,{{5,1}},1;
87 ACTIVITY;
88 ALTER,3,+1,1;
89 ACTIVITY,,,,"terminate";
90 CREATE,2,10,,3,1;
91 ACTIVITY,,15,,,,"Notify Crews";
92 AWAIT,,{{1,1}},ALL,,NONE,1;
93 ACTIVITY;
94 FREE,{{1,1}},1;
95 ACTIVITY,,TRIAG(4,4.5,5);
96 ALTER,1,-1,1;
97 ACTIVITY;
98 AWAIT,,{{4,1}},ALL,,NONE,1;
99 ACTIVITY,,TRIAG(1.75,2.25,3.25);
100 FREE,{{4,1}},1;
101 ACTIVITY;
102 ALTER,1,+1,1;
```

```
103 ACTIVITY,,TRIAG(16.5,17.5,18.5);
104 ALTER,3,-1,1;
105 ACTIVITY,,,,"Chalk678cont";
106 Chalk678cont: AWAIT,,{{5,1}},ALL,,NONE,1;
107 ACTIVITY,,TRIAG(1.75,2.25,3.25);
108 FREE,{{5,1}},1;
109 ACTIVITY;
110 ALTER,3,+1,1;
111 ACTIVITY,,,,"terminate";
112 terminate: GOON,1;
113 ACTIVITY;
114 COLCT,,TNOW,,,,,1;
115 ACTIVITY;
116 TERMINATE,13;
```
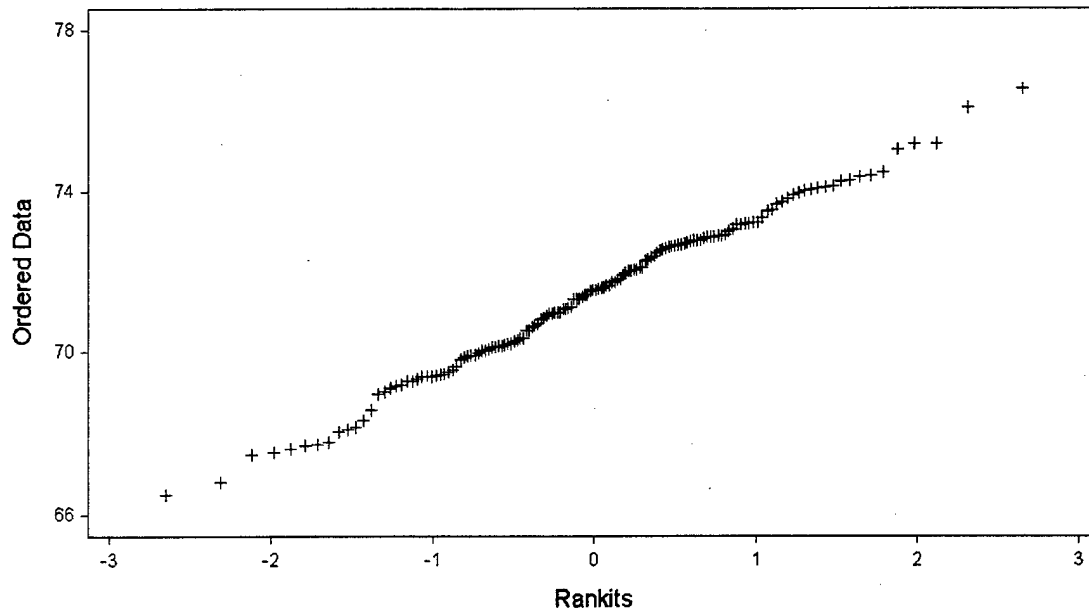
Appendix D: Tests for Normality
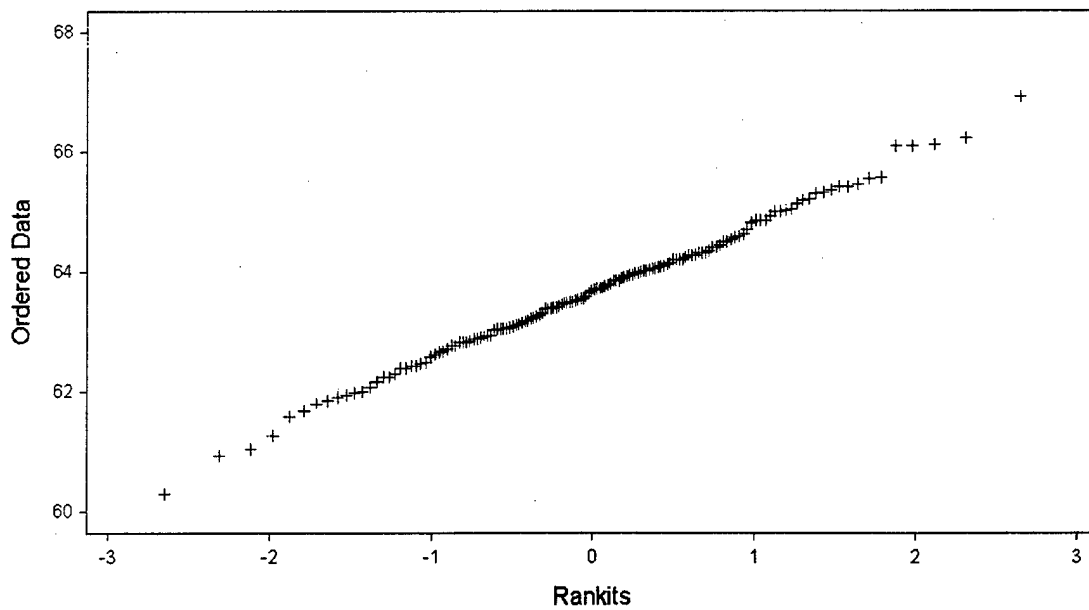
Wilk-Shapiro / Rankit Plot of MODEL1

Approximate Wilk-Shapiro 0.9890   150 cases

Wilk-Shapiro / Rankit Plot of MODEL2
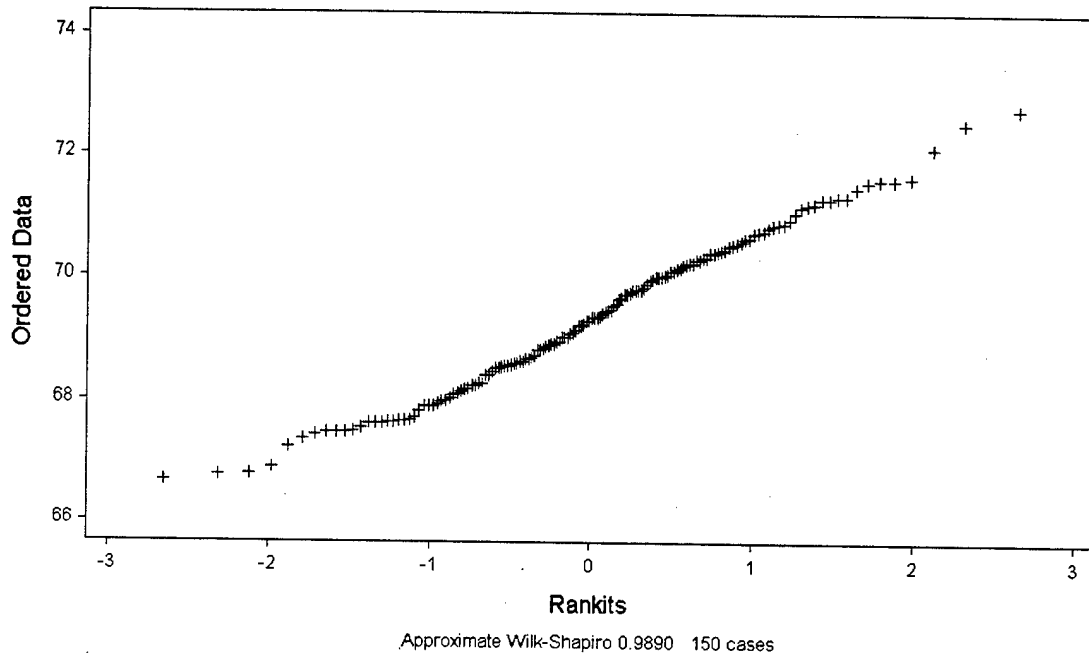
Approximate Wilk-Shapiro 0.9879   150 cases
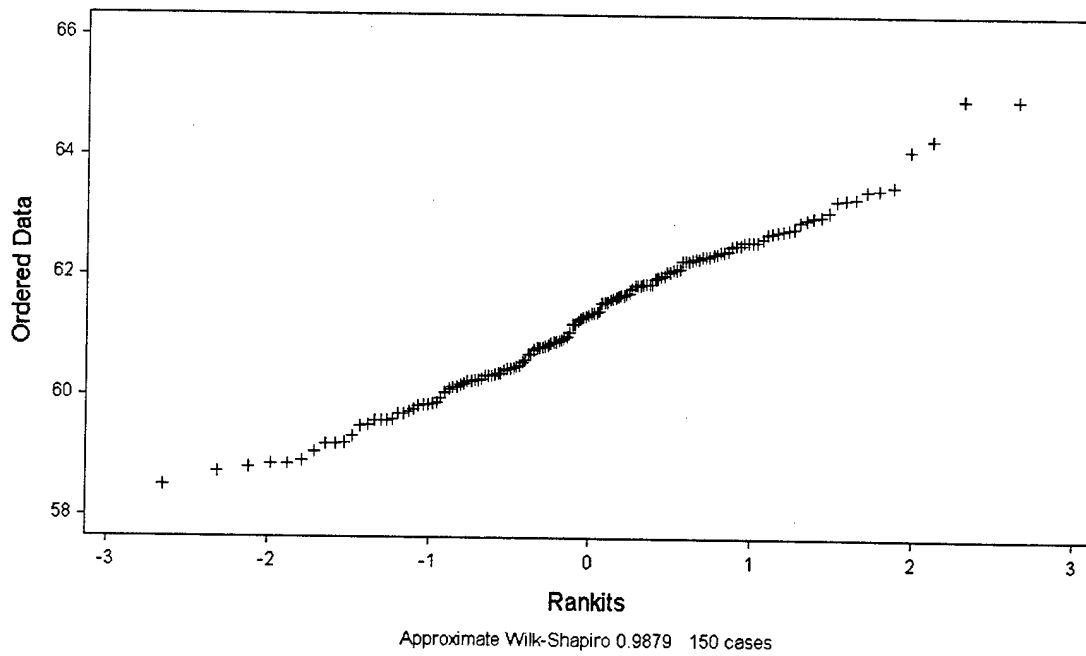
Wilk-Shapiro / Rankit Plot of MODEL3

Approximate Wilk-Shapiro 0.9933   150 cases

Wilk-Shapiro / Rankit Plot of MODEL4

Approximate Wilk-Shapiro 0.9962   150 cases

Bibliography

1. 4417 AEF (P)/HO. "4417th Air Expeditionary Force, Provisional: Consolidated Lessons Learned." n. pag. http//www.knowledge.langley.af.mil/afcks/default.htm, 10 February 1999.

2. Air Combat Command (ACC). "Concept of Operations for a CENTCOM Aerospace Expeditionary Force (Draft)". Langley AFB, VA. ACC/LG, 25 Nov 98.

3. Air Combat Command (ACC) Briefing. "Air Expeditionary Force (AEF) Planing and Prepositioning Status." Electronic Message, 24 March 1999.

4. Armed Forces Staff College. The Joint Staff Officers Guide, Pub 1. Norfolk, VA. n. pag. http://www.afsc.edu/pub1/afsc0000.htm, 31 May 1999.

5. Atkins, Lt Col Sheryl G. The Air Expeditionary Force: What You Need, When You Need It Naval War College Paper. Naval War College, Norfolk NAS, VA, June 1997 (AD-A328215).

6. Banks, Jerry, John S. Carson,II and Barry L. Nelson. Discrete-Event System Simulation (Second Edition). Upper Saddle River NJ: Prentice-Hall, 1996.

7. Barthelmess, Lt Col Bob. Class handout, Contingency Wartime Planning Course, IP-3000, Joint Strategic Planning System and Planning, Programming , and Budgeting System. Air University, College of Aerospace Doctrine, Research and Education (CADRE), 2 February 1997.

8. Benton, Technical Sergeant Bobby. Deployments NCO, 4th LSS/LGLX Seymour-Johnson AFB NC. Personal interview. 21 June 1999.

9. Buchanon, Lt Col Buck. Class handout, Contingency Wartime Planning Course, IP-5000, Crisis Action Procedures. Air University, College of Aerospace Doctrine, Research and Education (CADRE), 2 February 1997.

10. Connors, Thomas, Major (Ret.). Former Installation Deployment Officer, 1 FW Langley AFB VA, 1994-1997. Multiple personal interviews. 1999.

11. Crowley, Adrian M. and Richard L. Smith. Development of Process Definitions for War Reserve Materiel Management and Force Package Paring and Tailoring for the Exploitation of Integrated Information Systems and Their Impact on Combat Readiness. MS Thesis, AFIT/GLM/LAL/98S-3. School of Logistics and Acquistions Management, Air Force Institute of Technology (AU), Wright-Patterson AFB, OH, September 1998 (AD-B238883).

12. Department of the Air Force. Air Mobility Planning Factors. AFPAM 10-1403. Washington DC: HQ USAF, 1 March 1998.

13. Department of the Air Force. Deployment Planning. AFI 10-403. Washington DC: HQ USAF, 27 May 1998.

14. Department of the Air Force. Flying Operations. AFI 11-202V3. Washington DC: HQ USAF, 1 June 1998.

15. Department of the Air Force. USAF Concept of Operations for Expeditionary Aerospace Force Implementation (Draft). Washington DC: AFSAA/SAAC, 2 December 1998.

16. Department of the Air Force. USAF Deployment Management. AFPAM 10-417. Washington DC: HQ USAF, 1 May 1997.

17. Department of Defense. Verification, Validation, and Accreditation (VV&A) Recommended Practices Guide. Washington: Government Printing Office, November 1996.

18. Desktop Reference Book. Class handout, Contigency Wartime Planning Course. Air University, College of Aerospace Doctrine, Research, and Education (CADRE), 2 February 1997.

19. Duke, Colonel Gail. Commander, 366th Logistics Group, Mountain Home AFB ID. "On-Call AEW Tasking: 'Bombs on Target in 72 Hours'." Briefing to Air Force Institute of Technology Logistics-399 students and faculty, Air Force Institute of Technology, Wright-Patterson AFB OH 15 June 1999 .

20. Duke, Colonel Gail. Commander, 366th Logistics Group, Mountain Home AFB ID. Telephone interview. 29 June 1999.

21. Dumville, James C. "A PERT Statistical Analysis: The Probability That a Non-Critical Path Will Emerge Critical," Logistics Spectrum, 23-31 (Spring 1992).

22. EAF Public Affairs Guidance. "Expanded Expeditionary Aerospace Force (EAF) Guidance to supplement the FY00 Force Structure Announcement." Article n. pag. http://www.eaf.dtic.mil/eafpag399.html. 30 May 99.

23. Goodman, Glen W. "An Expeditionary Aerospace Force," Armed Forces Journal International. 18-19 (August 1998).

24.	Haffa, Robert P., Col. "Wake-Up Call (What the Air Force Study On Long-Range Planning Should Conclude)," <u>Armed Forces Journal International.</u> 54 - 58 (September 1996).

25.	Hill, Kenneth. Class handout, Contingency Wartime Planning Course, IP-4200, Force Packaging. Air University, College of Aerospace Doctrine, Research and Education (CADRE), 2 February 1997.

26.	Hogle, Lieutenant GeneralVoelger S. Vice Comander, Air Mobility Command, Scott AFB IL. "AMC's Mobility Role in the EAF." Briefing. 1999.

27.	Joint Chiefs of Staff. <u>Department of Defense Dictionary of Military and Associated Terms.</u> Joint Pub 1-02. Washington DC: JCS, 23 March 1994.

28.	Joint Chiefs of Staff. <u>Joint Operations and Execution System. Volume 1-Planning Policies and Procedures.</u> Joint Pub 5-03.1. Washington DC: JCS, 4 August 1993.

29.	Joint Chiefs of Staff. <u>National Military Strategy of the United States of America.</u> U.S. Government Printing Office: 1995.

30.	Keelty, Capt Kieran. Chief of Supply for 347 AEW, Student, Air Force Institute of Technology, Wright-Patterson AFB OH. Personal interview. 24 June 1999.

31.	Looney, William R. III. "The Air Expeditionary Force: Taking the Air Force into the Twenty-first Century," <u>Air Power Journal.</u> 4-9 (Winter 96).

32.	Macelli, Major Christopher and Major Robert Arands. AMC/DOX, Headquarters Air Mobility Command, Scott AFB IL. Personal interview. May 1999.

33.	Macelli, Major Christopher. Assorted AEF planning documents. May 1999.

34.	McClave, James, George Benson, and Terry Sincich. <u>Statistics for Business and Economics.</u> 7th ed. Upper Saddle River, NJ: Prentice-Hall, 1998.

35.	Murphy, Capt Jennifer. ACC/LGXX, Langley AFB VA. Multiple telephone interviews. 1999.

36.	Nash, George. Installation Deployment Officer, 347 FW, Moody AFB GA. Telephone interview. 25 June 1999.

37.	Neal, Capt Robert. Chief of Transportation for AEW VII, Student, Air Force Institute of Technology, Wright-Patterson AFB OH. Personal interview. 25 June 1998.

38. Neubaurer, Lt Col John A. <u>Air Expeditionary Forces Providing Operational Alternatives</u>. Naval War College Paper. Naval War College, Norfolk NAS, VA, June 1996 (AD-A312162).

39. Pritsker, A., O'Reilly, J., & LaVal, D. <u>Simulation with Visual SLAM and AWESIM</u>. New York: John Wiley & Sons, 1997.

40. Rand Corporation. "Research Highlights 1997." n. pag. http://www.rand.org/organization/paf/AR7012.web/highlights.html. 19 June 1999.

41. Ryan, Michael, General, Air Force Chief of Staff. "Expeditionary Aerospace Force for America." Keynote address to the National Air Force Association Convention, Washington, D.C. 14 September 1998.

42. Ryan, Michael, General, Air Force Chief of Staff. "The Promise of the Expeditionary Force," <u>Air Force Times</u>. 31 August 1998, sec. Opinion.

43. Shapiro, S. S. and R. S. Francia. "An Approximate Analysis of Variance Test for Normality," <u>Journal of the American Statistical Association, 67</u>: 215-216 (1972).

44. <u>Statistix Version 4.0 User's Manual</u>. St. Paul, MN: Analytical Software, 1992.

45. Trip, Robert, Lionel Galway, John Drew, Chris Fair, and Timothy Ramey. "A Global Infrastructure to Support EAF," <u>Air Force Journal of Logistics, 23</u>: 2-7, 38-39 (Summer 1999).

46. USCENTAF. "United States Involvement in the Middle East." Article. n. pag. http://www.centaf.af.mil.htm. 27 Aug 98.

47. Vo, Tam T. 1st Lieutenant. <u>Exploratory Analysis of the Deployment Feasibility of United States Air Force Air Expeditionary Forces</u>. MS Thesis, AFIT/GLM/LAL/97S-8. . School of Logistics and Acquisition Management, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1997 (AD-A329996).

48. Vork, Chief Master Sergeant (Select) Robert. 366th Logistics Group, Mountain Home AFB OH. Telephone interview. 24 June 1999.

49. Wages, Brian E., Col. "The First With The Most 'USAF's Air Expeditionary Force Takes The Offensive on Power Projection'," <u>Armed Forces Journal International</u>. 66-71 (September 1996).

50. Webb, William T. Captain. Value of Increased Use of Scheduled Maintenance on Aircraft Availability and Maintenance Cost of the C-5. MS Thesis, AFIT/GTM/LAL/98S-8. School of Logistics and Acquisition Management, Air Force Institute of Technology (AU), Wright-Patterson AFB OH, September 1998 (AD-A354251).

51. White House. <u>A National Security Strategy for a New Century</u>. October 1998. n. pag. http//www.dtic.mil/doctrine/jel/other_pubs/nssr.pdf.

Vita

Captain Robert L. Charlesworth was born 17 April 1972 in Delta, Colorado. He graduated from Medical Lake High School in Medical Lake, Washington in June 1990. He earned a Bachelor of Science degree in Human Factors Engineering and received a regular commission from the United States Air Force Academy in June 1994.

His first assignment was to the 1st FW at Langley AFB, Virginia as a Logistics Plans Officer. He was assigned to the 1st Logistics Support Squadron and held three jobs from July 1994-June 1997. During that time he acted as Installation Deployment Officer for numerous Southwest Asia deployments including Operation VIGILANT WARRIOR and AEF II. He was assigned to the 13th Air Force, Air Support Squadron, Andersen AFB, Guam in July 1997 as OIC of Combat Plans.

He entered the Logistics Management program at the Graduate School of Logistics and Acquisition Management at the Air Force Institute of Technology in May 1998. Upon graduation he will be assigned to the Air Force Security Assistance Center at Wright-Patterson AFB, Ohio. He is married to the former Amelia Edgerton from Newport News, Virginia.

Permanent Address: 208 Tabb Lakes Drive
                     Yorktown, VA 23693

13. ABSTRACT (Maximum 200 Words)

Seven AEF deployments have been accomplished in the Southwest Asia area of responsibility; none have met the Air Force's stringent 72-hour criterion. This exploratory study quantifies the responsiveness capability of the AEW concept. Based on a Monte Carlo simulation methodology this study concludes that the on-call AEW at Mountain Home AFB does not have the capability to meet the 72-hour criterion.

Additionally, this study examined the effect of three departures from the baseline model on responsiveness capability. These departures included: increasing airlift throughput capacity, incorporating limited airlift failure, and employing an air-refueling scenario. The simulation models incorporating these departures resulted in the respective approximate probabilities of 90%, 0%, and 28% for meeting the 72-hour criterion. The limitations of this study are discussed in the context of both the results and their implications, and future research is suggested toward quantifying policy/resource alternatives to assist senior Air Force decision-makers.

14. Subject Terms **Air Expeditionary Force, Deployment Planning, Expeditionary Aerospace Force, On-Call Air Expeditionary Wing**			15. NUMBER OF PAGES 136
			16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT UL

AFIT RESEARCH ASSESSMENT

The purpose of this questionnaire is to determine the potential for current and future applications of AFIT thesis research. **Please return completed questionnaire** to: AIR FORCE INSTITUTE OF TECHNOLOGY/ ENA 2950 P STREET, WRIGHT-PATTERSON AFB OH 45433-7765. Your response is **important.** Thank you.

1. Did this research contribute to a current research project?   a. Yes   b. No

2. Do you believe this research topic is significant enough that it would have been researched (or contracted) by your organization or another agency if AFIT had not researched it?

                                                   a. Yes   b. No

3. **Please estimate** what this research would have cost in terms of manpower and dollars if it had been accomplished under contract or if it had been done in-house.

        Man Years_____ $_____

4. Whether or not you were able to establish an equivalent value for this research (in Question 3), what is your estimate of its significance?

    a. Highly   b. Significant   c. Slightly   d. Of No
       Significant   Significant   Significance

5. Comments (Please feel free to use a separate sheet for more detailed answers and include it with this form):

_____   _____
Name and Grade   Organization

_____   _____
Position or Title   Address